DOCUMENT RESUME

ED 102 996 IR 001 680

AUTHOR Bayunus, Owais
TITLE A Cost Analysis of the Automated Systems Control Group, The Acquisitions Department and the Catalog Department of the Central Technical Services.
INSTITUTION Cornell Univ., Ithaca, N.Y. Univ. Libraries
PUB DATE Jan 75
NOTE 102p.

EDRS PRICE MF-$0.76 HC-$5.70 PLUS POSTAGE
DESCRIPTORS Cataloging; *Costs; Job Analysis; Library Acquisition; *Library Automation; *Library Technical Processes; Manpower Utilization; Shared Services; *University Libraries; *Work Simplification
IDENTIFIERS Cornell University; *Time and Motion Studies

ABSTRACT

A time and cost study and a work sampling study were conducted during the period of June 1974 to November 1974 in the Central Technical Services department of the Cornell University Library System. This department renders acquisitions and cataloging services to all the endowed college and departmental libraries in the system except the Hotel Administration and Law Libraries. The Automated Systems Control Group, the Acquisitions Department, and the Catalog Department were studied to provide information and recommendations for the improvement of the Central Technical Services operations. Specific recommendations resulting from those studies are provided together with estimates of the costs and the time requirements of various operations. (Author/DGC)

A COST ANALYSIS
OF THE
AUTOMATED SYSTEMS CONTROL GROUP,
THE ACQUISITIONS DEPARTMENT
AND THE
CATALOG DEPARTMENT OF
THE CENTRAL TECHNICAL SERVICES
CORNELL UNIVERSITY LIBRARIES

A Project Report

Presented to the Faculty of the Graduate School

of Cornell University in Partial Fulfillment

of the Requirements for the Degree

of Master of Engineering (Industrial)

by

Owais Bayunus

January 1975

TABLE OF CONTENTS

SUMMARY

The Central Technical Services of the Cornell University Library System acquires and catalogs about 70,000 titles each year. It is responsible for rendering its acquisitions and cataloging services to all the endowed college and departmental libraries in the system except the Hotel Administration and Law Libraries.

The Automated Systems Control Group (ASCG), the Acquisitions Department and the Catalog Department are the three main areas which offer most of the technical services. The present report is aimed at providing the information and/or recommendations for the following to the management of the Central Technical Services.

1. Cost of Acquiring and Cataloging a monograph for the Industrial and Labor Relations Library (ILR) which is not an endowed departmental library but a statutory unit.

2. The Productive Time Ratio for employees in the Central Technical Services.

3. Work pressure on the employees and the amount of time available for additional load.

4. Work smoothing by work allocation based upon the present average level of the productive activity of the employees throughout the Technical Services.

5. Rescheduling the procedure or combining different sections to ease the flow of work within and among each Department.

6. Proposal for a better lay out.

7. Statistical support for the accuracy of the time of cataloging a monograph and the Productive Time Ratio and for other useful results determined.

A Time and Cost Study and a Work Sampling Study were conducted for this purpose during the period of June 1974 to November 1974.

The cost of processing a monograph is found to be $9.88. This figure may now be quoted to the ILR library for the acquisition and the cataloging of their monographs in the Central Technical Services.

The overall Productive Time Ratio for the three departments is 54.8% and the average number of hours available to employees for further load is about 421 hours per year per employee.

The current productive activity level is 1111.9 hours per employee per year.

Recommendations for a better layout show a reduction of about 512 hours each year wasted in walking.

Providing the LC Card Number by Slip Puller of the Searchers in Acquisitions Department saves about 168 hours of more expensive labor and an equivalent time at the OCLC terminal per year.

Acknowledgements

I wish to extend my deep appreciation to my advisor Professor Andrew Schultz Jr. for his worthy advice and criticism, all of which has been invaluable for the completion of this study.

I am greatly thankful to Mr. Ryburn Ross, Assistant Director for Technical and Automated Services, for his keen interest in this study and for extending me the financial support to carry out this work.

My special thanks are to Mr. William Treat, Manager of Automated Systems Control Group, who has offered me full cooperation. He introduced me to individuals necessary to my work, offered me advice when asked, and sought to make available to me all resources which could help me with my work.

To all the employees of the Central Technical Services who were concerned directly or indirectly with this study, I offer my sincere thanks, in particular to Pat Hullinger who typed this report for me.

I would like to thank my wife, Kishwar, for her patience and for her help in checking my calculations.

INTRODUCTION

Central Technical Services in Olin Library processes monographs, serials, government documents and pamphlets arriving from publishers, from gifts and from many other sources. It does this for Olin Library, Uris Library, the Fine Arts Library, the Business Library, the Engineering Library, the Math Library, the Physical Sciences Library, the Music Library, the Industrial and Labor Relations Library, and the Africana Studies Center.

The first phase of the present study deals with the determination of the cost of processing (acquiring, cataloging and card production) an Industrial and Labor Relations (ILR) Library monograph in the Central Technical Services. A time and cost study was conducted for this purpose. The time of processing the orders received for the ILR Library monographs as well as the times required to process their books in the Acquisitions Department and the Social Sciences section of the Catalog Department were determined. The total labor cost in any given section was found by multiplying the time required to process a monograph in that section with the average wage of the employee. The time figures obtained were only for the actual labor expended and did not include interruptions and nonproductive time. The resulting figure was therefore divided by a factor called the 'Productive Time Ratio' (PTR) also called the 'Work Efficiency Factor'.

The Productive Time Ratio is found as follows:

$$\text{Productive Time Ratio (PTR)} = \frac{\text{Number of Hrs. spent in 'productive work' per year}}{\text{Total number of Hrs. Employees are being paid for in one year}}$$

The actual value of the Productive Time Ratio (PTR) for the employees in the Central Technical Services was not known. A figure of 60%[1] was used, initially, to quote the price of processing a monograph to the ILR Library.[2]

The second phase of this study deals with the use of the techniques of Work Sampling or the Ratio Delay Analysis to assess an exact figure of PTR for the employees in the Acquisitions and the Catalog Departments. This study was performed on a broader basis than the first phase study as it included in the study all the employees of the Automated Systems Control Group (ASCG), the Acquisitions and the Catalog Departments.

Work Sampling was aimed at providing the value of the Productive Time Ratio for each specialized group of employees in the ASCG, the Acquisitions and Catalog Departments, and the overall ratio for the three departments combined. It was also intended to use Work Sampling as a double check on the standard values of doing certain tasks obtained from the time and cost study, to provide figures to show the pressure of work on the groups in terms of the productive time, to find ways of diminishing the work pressure if it were high and, if low, then to find how much load can further be

undertaken by the employees without the need of hiring any new person.

I have gone into detailed analysis of work in these Departments, and have been able to find ways of diminishing the time of searching a monograph in the Catalog Department, on the OCLC terminal also.

---

[1] The results of the Time and Cost Study were used to quote the price of cataloging an ILR monograph in the Central Technical Services. Upon acceptance of the cost by the ILR library, the Central Technical Services acquires and catalogs the ILR monographs also, from September 1974. The figure of 60% used for the PTR came from a study of office work and not from any study in the Libraries in Cornell.

[2] Throughout this report this study is referred to as "Time Study".

PRESENT SYSTEM OPERATION

Orders and suggestions for puchases of monographs, pamphlets, etc. are given to the Acquisitions Department of Central Technical Services by Departmental Librarians, subject-area Bibliographers, Faculty Members, Students, and the Assistant Director for Collection Development.

Cornell University Libraries use the Title II depository catalog cards as the initial selection tool for the titles to be ordered. Orders are also given on AQ2 processing and ordering slips and on some special cards which are needed to be filled in completely by the staff members and the students, etc.

All potential orders are reviewed by the Assistant Director for Collection Development prior to their being further processed. The orders are then returned to the Acquisitions Department where they are searched to find if any of the titles are already in the Cornell University Library System. At this stage some other useful information such as the correct form for the author's name and for the title and the status of a book, is also determined. If the searchers are unable to find complete information for the book in the card catalog, the bibliographies, and other printed sources available to the Acquisitions Department, they go to the Ohio College Library Center (OCLC) terminal which is located in the Catalog Department. They try to find if the book or if another edition of the book has been cataloged by the Library of Congress or any other Member Library participating in the OCLC system.

If a book is found on the terminal, then sufficient information needed to acquire the book from dealers is noted on an AQ2 slip which is kept in an Outstanding Order File (OOF). The rush orders are typed right away and mailed. Non-rush orders are edited, keypunched and get printed on a computer and are then mailed. Rush orders are also edited, keypunched a get printed on a computer to keep the record up-to-date.

Upon the arrival of the monographs, the Shipping Room personnel open the packages keeping the titles from the same dealer together. These books are then brought up to the receiving table in the Acquisitions Department. The appropriate slip for each book is pulled from the Outstanding Order File and placed inside the book.

If the books have the Title II depository cards, then the books are sent directly to the Catalog Department. If the books have AQ2 slips (which give information about the book from any source other than the Library of Congress) then it is determined whether enough searching has been done before they are sent to the Catalog Department. When it is ascertained that a correct book is received and that each item of information on the slip is accurate, the book with the slip inside it is then sent to the Catalog Department. Otherwise, a return slip is filed for a wrong book received and the book is sent back to the dealer.

The charts on the following pages show the breakdown of the operations performed.

Chart 1 shows the processes involved when the orders are received by the employees in Acquisitions Department.

Chart 2 is the detailed presentation of the steps involved in the searching operation.

Chart 3 presents the operations involved in the Acquisitions Department when the books arrive.

SL, SM, DW, JM and JG are the initials of the names of some of the employees in these sections.

CHART I: PROCESSING OF ORDERS FOR BOOKS

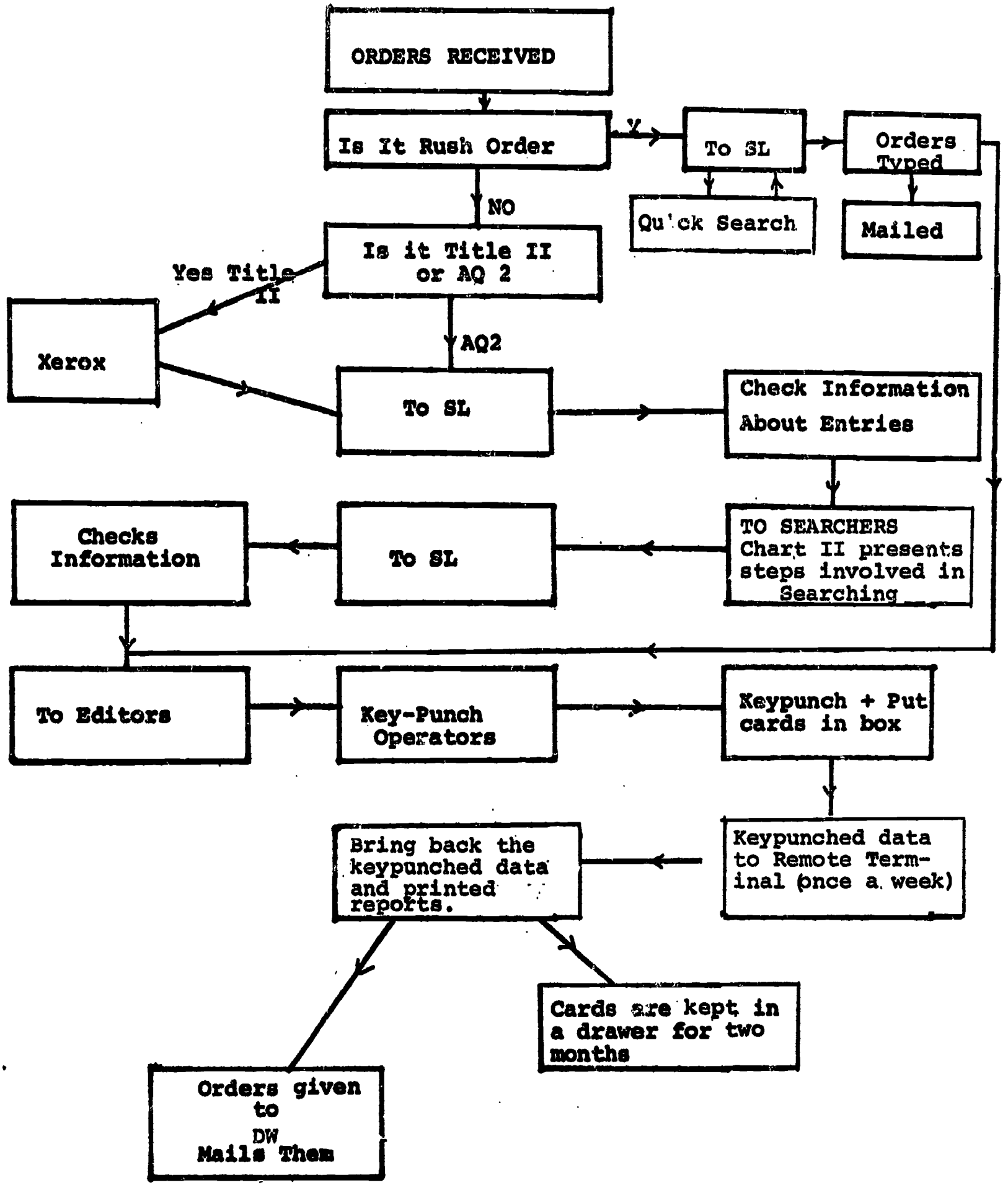


CHART II: SEARCHING OPERATION

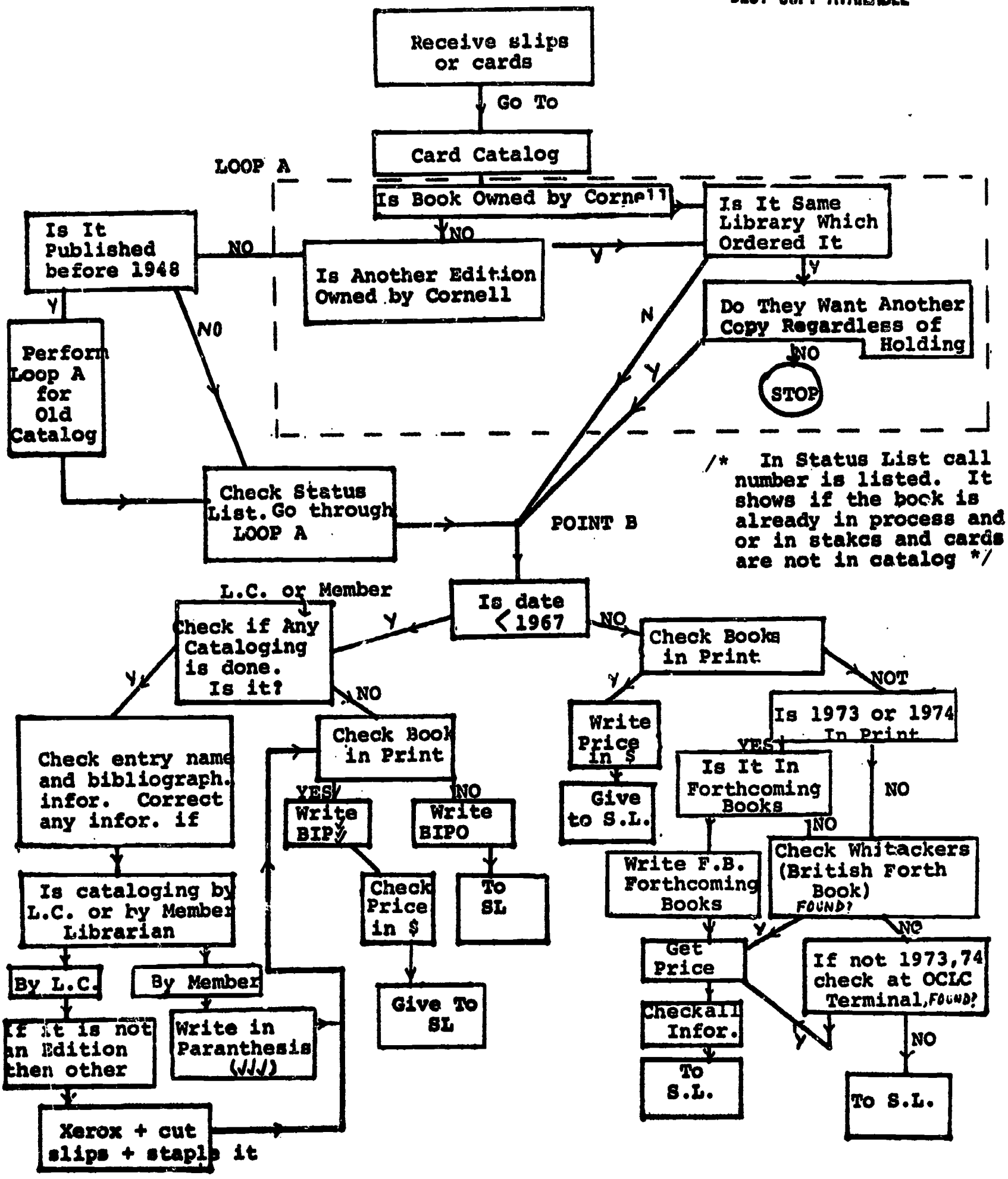
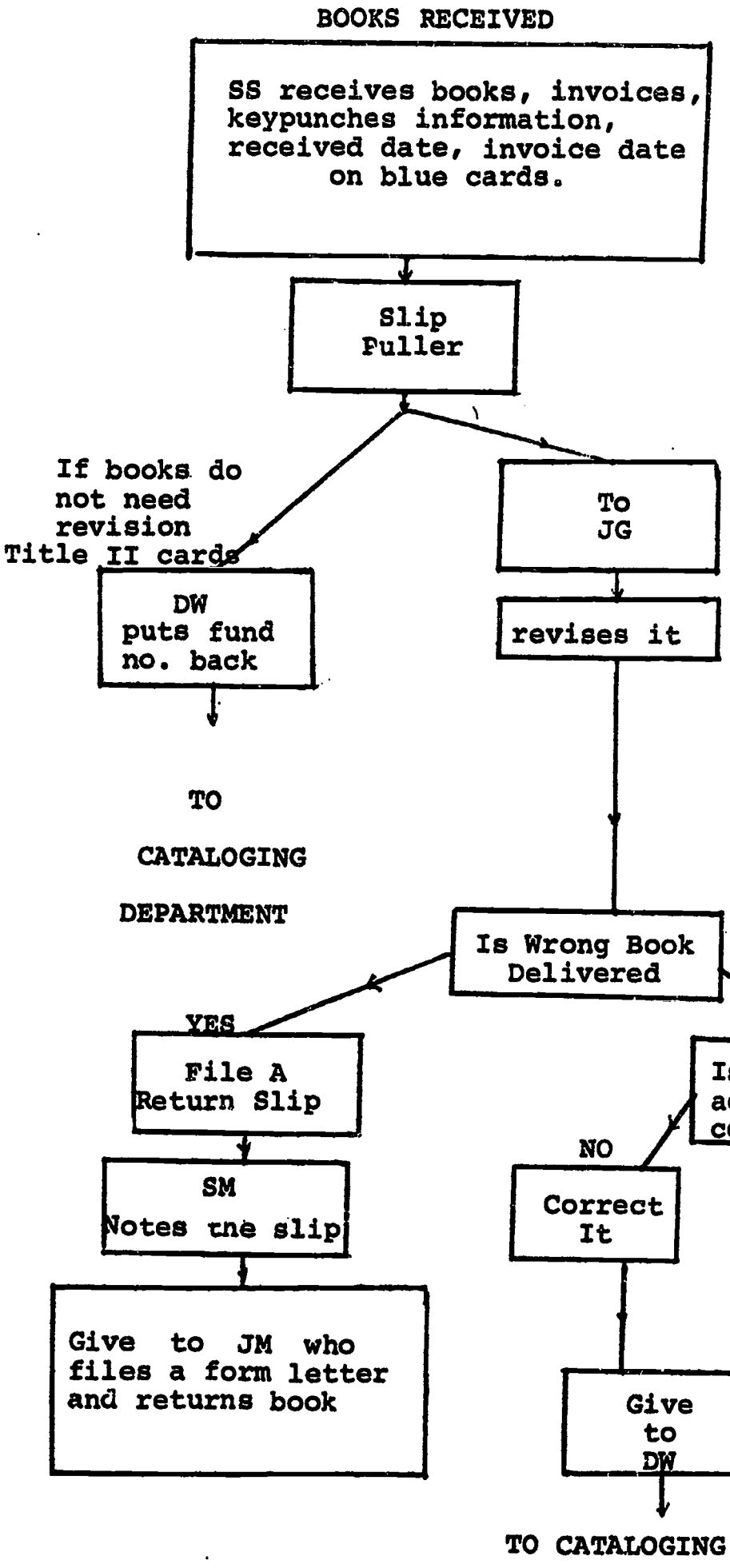


CHART III. BOOKS RECEIVED



Revision:

1. Checks inform on AQII and computer cards accurately matches the book.
2. All relevant infor. is noted on AQII's.
3. Checks if enough searching is done before it is sent to cataloging.

The Catalog Department is comprised of a team of searchers and eleven teams of professional and L.C. catalogers each of which is responsible for cataloging titles in different fields. This department prepares information for all the monographic and thesis materials and all added volumes and copies. Cataloging is done in the fields of Sciences, Slavic, Germanic, Humanities, Social Sciences, Romance Languages, Music, Fine Arts and some special cataloging for books written in the vernacular languages of South Asia, South East Asia and East Asia.

When books arrive in the Catalog Department they are searched on the OCLC terminals. If either LC-MARC or member library cataloging copy is available, the titles are assigned by subject to the appropriate cataloging section. These titles are usually cataloged by a Library Assistant III although professional catalogers, who are also the Head of their respective teams, often assist with member copy.

Titles with non-MARC-LC copy not in the Cataloging Support System data base are also given to a Library Assistant III who assigns MARC tags for inputting. The remaining titles are held for two additional searches a month apart. Each additional search is made for those titles which were not found in the previous search. Whenever a title is found on the terminal, it is immediately given to the appropriate catalogers. At the end of the second additional search the titles unavailable in the data

base are assigned to the cataloging sections for original cataloging. Original cataloging involves the cataloging from scratch by the professional catalogers.

Inputting in the terminal involves placing the books' bibliographic information in the OCLC data base in temporary storage.

Proofreading involves calling up a book's record from the temporary storage and correcting any mistakes in the cataloging. Once satisfied with the information, the proofreader authorizes production of catalog cards, removes the record from the temporary storage and causes the record to become a permanent part of the computer data base. This cataloging information is added to the data base only if the record is new to the system. Later on if the same title is cataloged by the Library of Congress, the bibliographic information fed in by the member library, is removed and L.C. information is placed permanently in the data base.

When a record is called from the data base and used to create a permanent cataloging record for the library, there is a one-time charge of 85 cents. Merely calling a record to see if it exists, does not cost the library anything.

METHOD OF TAKING OBSERVATIONS FOR THE TIME AND COST STUDY FOR THE ILR LIBRARY

The material received in the ASCG, the Acquisitions Department and the Catalog Department passes through a series of small operations performed by the workers employed in these areas. As a monograph passes from one hand to another or from one operation to another, a value is added to it. Knowing the stage of processing, we can evaluate the total money value added to the monograph up to that stage, since its arrival in the Olin Library.

The complete process of work in the Automated Systems Control Group, the Acquisitions Department and the Catalog Department was divided into short and independent operations. We used a sample of orders for the ILR Library to find the cost of processing a unit order in the Automated Systems Control Group and in relevant areas of the Acquisitions Department. A sample of ILR monographs was used to determine the cost of processing a monograph in other areas of the Acquisitions Department.

Since ILR monographs were not available to the catalogers in Olin Library,[1] a sample of social sciences monographs was used to develop the cost of cataloging.

In the Acquisitions Department the time of processing a single piece of material, whether a slip or a monograph, is very short. The time of processing a complete batch of

[1]NOTE: Central Technical Services were responsible only for acquiring the monographs for ILR library. Those monographs were then cataloged by the Catalogers in the ILR library itself.

material in a sample was, therefore, noted by the employees involved in the operation. In some instances like the time for keypunching the cards and their verification, I timed the workers to arrive at the gross figures. An average cost figure was calculated for a single monograph.

As the time of cataloging a monograph is quite high, individual times for each monograph could be determined with considerable accuracy. Individual times were therefore noted by the employees. A PL/C computer program was written and used to determine the confidence intervals for the observed process times for 90%, 95% and 99% confidence levels for each of the steps involved in cataloging based on the sample observed.

The results of Time Study are presented in Appendix I and the results of the PL/C program are discussed in Appendix V.

METHOD OF TAKING OBSERVATIONS FOR THE WORK SAMPLING STUDY

A list of the names of all the full-time permanent employees and a selected number of part-time employees in the ASCG, the Acquisitions and the Catalog Departments was prepared. The list contained about 75 names. I had a brief interview with each of the employees to understand the type of work they do and the places where their jobs are performed.

I divided the employees of the Acquisitions Department into 5 groups. Group 1 dealt with the processing of orders, Group 2 did the searching and editing of the order slips, Group 3 was concerned with the books upon arrival, Group 4 was comprised of the people working in the Monographic Series Section and the Group 5 was the Gifts and Exchange Section.

Similarly, the employees of the Catalog Department were divided into groups depending upon the classifications of the titles they catalog.

The names of the employees in each group were noted on a sheet of paper with columns showing the work locations for the individuals in that group. A check mark was made in front of an individual in the block representing the location of his work at the time of observation. If found walking, training or consulting, a check was made also in the proper block for the individual. Similarly a check for non-productive work was also made.

A daily list of all those employees who were absent for the day and who would come late was provided to me by the secretaries of the Acquisitions and the Catalog Departments. From my observation sheet I cancelled the names of all those employees who were not present at the time of observation.

I observed the activities of 4-5 groups at a time and the interval between two consecutive observations would range from 5 minutes to 12 minutes. It would depend upon the time required to locate every individual under observation. Because of the difficulty of locating every employee, this interval was usually larger in the initial sets of observations. After two or more sets of observations had been taken, I knew more about the location of the persons being observed and therefore the interval between two observations could be reduced.

Sometimes I was not able to locate some of the individuals at all. In that case, I didn't make any check mark in any of the productive or non-productive categories.

A check was made under the 'avoidable delays' column if a person was found not working, or found coming late or arranging his work area or reading a newspaper or magazine, etc. Personal delays correspond to strictly unavoidable personal delays like going to the washroom or doing some other needed work.

Since 12 to 15 persons were observed in each set, it

was not long before a sufficient number of observations was available to provide some statistics. The total number of sets of observations made during the three month study was 182 whereas the total number of observations for all individuals was 2307. The results of Work Sampling Study are presented in Appendix II.

I have made spot checks also, to determine if the employees take notice of my presence or not. The result of spot checking is also presented along with the results of the Work Sampling Study.

Table I shows the total time available to the employees to do their productive work.

Full time employees are paid for a total of (52 weeks/year x 39 hrs/week=) 2028 hours per year. The time spent in vacation, sick leave, national holidays and coffee breaks is not available for the productive work. According to Table I, 389 hours are lost due to vacation etc. and 101 hours are lost due to the delay in resumption of work after coffee breaks. This brings the total unavailable time up to 490 hours or the available time to 1538 hours each year.

Table II gives the values of the observed productive time based upon the available number of 1538 hours, and the Productive Time Ratio, based upon 2028 pay hours per year.

The 95% Sample Error is also determined and given in Table II.

TABLE I: TIME AVAILABLE FOR PRODUCTIVE WORK
TOTAL NUMBER OF HOURS = 2028 PER PERSON PER YEAR

ANNUAL LEAVE = $17^{(1)} \times 8$	=	136 Hrs.
PERSONAL LEAVE = 3 x 8	=	24 Hrs.
SICK LEAVE[2] = 8 x 8	=	64 Hrs.
NATIONAL HOLIDAYS = 8 x 8	=	64 Hrs.
		288 Hrs.
COFFEE BREAK [3] $\frac{1}{2}((5 \times 52)-36))-\frac{1}{4}(45)$	=	101 Hrs.
TOTAL NONPRODUCTIVE TIME DUE TO HOLIDAYS, VACATION	=	389 Hrs.
AVERAGE DELAY[4] FROM COFFEE BREAK = 1/2 hrs. EACH WORKING DAY	=	101 Hrs.
TOTAL HRS. NOT AVAILABLE FOR WORK AND DELAY IN COFFEE BREAK EACH YEAR	=	490 Hrs.
AVAILABLE HRS. = 2028-490	=	1538 Hrs.

OR APPROXIMATELY = 128 Hrs. per person per month

[1]This is average number of days annual leave employees under study are entitled to take.

[2]Although employees are entitled to take 9 days sick leave each year, 8 is an average figure they had been taking off during the previous years (Reference: Budget Department, Olin Libary).

[3]Every employee is given a break of 15 min. in the morning and 15 min. in the afternoon, for coffee every day. On Fridays the 15 min. break is given only in the mornings.

[4]On average, it takes an extra 15 min. delay to start the work after each coffee break. This delay is not included in the results of the avoidable delays of the Work Sampling study.

TABLE II: PRODUCTIVE TIME RATIO AND SAMPLE ERROR

TOTAL NUMBER OF OBSERVATIONS n= 2307

AVERAGE OF THE 'OBSERVED PRODUCTIVE TIME' = 72.3%[1]

AVAILABLE NUMBER OF HRS. FOR WORK AFTER DEDUCTION OF VACATION ETC. = 1538 Hrs. per year

TOTAL NUMBER OF HRS DEVOTED TO PRODUCTIVE WORK = 1538 x 0.723 = 1111.9

PRODUCTIVE TIME RATIO EXPRESSED AS A PERCENTAGE = $\frac{1111.9}{2028} \times 100 = 54.8\%$

$$95\% \text{ SAMPLE ERROR} = \pm 1.96 \sqrt{\frac{(0.548)(1-0.548)}{2307}} = \pm 1.96 \sqrt{0.000107}$$

$$= \pm 1.96 \times 10^{-3} \times 10.36 = \pm 0.02031$$

$$= \pm 2.03\%$$

This shows, we are 95% confident that the value of Productive Time Ratio, as obtained from the sample of observations taken during the Work Sampling Study lies in the interval 54.8 ± 2.03.

---

1 Please see Appendix II for the calculation and the breakdown of the Productive Times for ASCG, the Acquisitions and the Cataloging Departments and for each section in these three Departments.

RECOMMENDATIONS

Based upon the Time and Work Sampling Studies, recommendations for decreasing the time of processing certain tasks or easing the flow of work are discussed and presented in the following pages.

Recommendations for future study are also given at the end of this section. Each recommendation is discussed separately under the proper title.

SAVINGS IN THE TIME TO SEARCH A MONOGRAPH AT OCLC TERMINAL WHEN L.C. CARD NUMBER IS KNOWN

Upon the arrival of books in the Acquisitions Department, the slips, which bear the information about these books, are pulled from the Outstanding Order File and placed in the proper books before being taken to the Catalog Department.

A random sample of monographs was given to the slip puller who was asked to write the L.C. Card Number of those monographs which bear this number. It took her 1 hour to pull the slips and place the slips inside 50 monographs, 15 out of which were added copies, replacement or Cornelliana and therefore did not have to be checked for the L.C. Card Number. The remaining 35 were searched for the card number, 11 did not bear the number. The number for the remaining 24 was noted on the AQII slips in a space which holds the title L.C. Card Number. This one hours' work is analyzed as follows:

Average time to pull the slips, search the L.C. Card Number for the 35 titles and write it on slips for those which have the number	=	60.000 min.
From the time study[1] the average time to pull 50 slips and place it in the relevant 50 monograph without writing the L.C. number = 0.017 x 60 x 50 =		51.000 min.
Searching the L.C. Card Number and noting the number on 35 slips requires	=	9.000 min.
	=	0.26 min. per monograph

[1] Appendix I, Table V.

On the OCLC Terminal, two samples at two different times were given to the Searchers in the Catalog Department. One sample had the L.C. Card Number written on the slips and the other did not. The total number of monographs with L.C. Card Number on slips were (67 + 24) 91, while with no information on the slips were (65 + 10) 75.

Time to search a monograph at the terminal, with L. C. Card Number on slips
= (55 + 20)/91 = 0.82 min.

Time to search a monograph at the terminal without L.C. Card Number on slips
= (60 + 20)/75 = 1.07 min.

Savings in time per monograph when the L.C. Number is written on the slips
= 1.07 - 0.82 = 0.25 min.

The searchers in the Acquisitions Department were also requested to keep note of the number of titles searched, the number which is ultimately taken to OCLC Terminal and also the number of titles found on the OCLC Terminal.

Out of a total of 932 titles searched during December 6, 1974 to December 12, 1974, 59 were ultimately taken to the OCLC terminal and 21 were found to exist in the data base and cataloged by the Library of Congress. The time to write the L.C. Card Number there is negligibly small.

The savings in the time of the Searchers in the Catalog Department is 0.25 minutes and is comparable to the time required by Slip Puller to search and write the L.C. Card Number, 0.26 minutes.

It is recommended here that the Searchers in the Acquisitions Department and the Slip Puller be asked to write the available L.C. Card Number of the monographs on the slips which accompany the books from Acquisitions to the Catalog Department.

The yearly gain is not only in terms of the savings in time of the more expensive labor but the savings gained at the OCLC terminal itself.

Assuming 90% of the titles, searched on the terminal, will be provided with the L.C. Card Number, an annual savings of about 168 hours can be accomplished in searching the anticipated number 45000 of the monographs that will be processed on the terminal next year.

COST OF PROCESSING A MONOGRAPH IN THE CENTRAL TECHNICAL SERVICES BASED UPON PTR EQUAL TO 54.8%

As the time and the cost of processing a monograph in each section of the ASCG, the Acquisitions and the Catalog Departments and the value of Productive Time Ratio for the Central Technical Services are established, the actual cost of processing a monograph is now determined as follows:

The value of PTR for the ASCG is 60.4%, for the Acquisitions Department is 52.0% and for the Catalog Department is 56.0% (Appendix II).

The PTR for the employees in the Shipping Room and in Marking and Plating Section is assumed to be equal to 54.8%, the average value of PTR for the three departments combined.

a) Labor Cost per Monograph

Labor Cost in Shipping Room[1]	= $0.0202
Labor Cost in Marking Section	= 0.0507
Labor Cost in Plating Section	= 0.0212
Total	= $0.0921

Actual Labor Cost in Shipping Room, Marking and Plating Sections
= $0.0921/0.548 = $0.1680

[1] Please see Appendix I for the labor costs in Shipping Room, Marking and Plating Sections.
All other labor costs are also taken from Appendix I.

Labor Costs in Acquisitions Department	= $0.9639
Actual Labor Cost in Acquisitions Department = 0.9639/0.52	= $1.8530
Labor Costs in ASCG	= $0.0892
Actual Labor Cost in ASCG = 0.0892/0.604	= $0.1476
Cost for Searching	= $0.0797
Cost for Cataloging	= 1.5766
Total	= $1.6563
Actual Labor Cost in Catalog Department = 1.6563/0.56	= $2.9570
Total Direct Labor Cost	= $5.1256
Total Overheads = 37% of Direct Labor Cost = 5.1256 x 0.37	= $1.8964
Total Labor Cost per Monograph	= $7.0220

b) Material and Equipment Costs per Monograph

Acquisitions Department	= $0.0208
ASCG	= $0.0751
Acquisition and Inprocess Control System	= $1.3027
Cataloging Support System	= $1.4439
Marking and Plating	= $0.0140
	$2.8565

Total Cost of Processing a Monograph

= $7.0220 + 2.8565 = $9.8785

The figure quoted to the ILR library was $9.25. As mentioned earlier it was based upon a value of PTR equal to 60%.

Since the actual cost of processing a monograph is found to be $9.8785, this figure may now be quoted to the ILR library as the cost of acquiring and cataloging their monographs in the Central Technical Services.

RECOMMENDATIONS FOR WORK SMOOTHING WITHIN THE THREE DEPARTMENTS

Total Time consumed in productive work per year	= 1111.9 Hrs.
Average time consumed in strictly unavoidable delays due to personal work (Table V) = 5.23 x 2028	= 106.0 Hrs.
Unavailable time due to vacations, holidays, leave etc. (Table I)	= 389.0 Hrs.
Total	1606.9 Hrs.
Average time available to each employee for additional productive work = 2028-1606.9	= 421.1 Hrs.

This shows that the Central Technical Services has a potential of undertaking about 37% more load than is presently being undertaken.

Based on the number of orders sent to the dealers, the work load in the three departments is usually at its minimum in the winter months of January, February and March[1], rises up in June, July and August and then slowly decreases in September, October and November. December is the month in which the least work is done due to Christmas vacations etc.

Assuming a work load of 100 during the period of the present study, the workload during the period of peak load is about 15% higher and that in January to March about 21% lower.

With the present man-hours available for work, Central Technical Services can cope with the high pressure during the summer months. During a summer a further (37-15=) 22% work load can be undertaken.

[1] Figures provided by Mr. William Treat, Head Automated Systems Control Group

TABLE III. NUMBER OF EMPLOYEES REQUIRED IN EACH SECTION OF ASCG AND ACQUISITIONS DEPARTMENT. (BASED UPON CURRENT LEVEL OF PRODUCTIVE ACTIVITY)

Average Productive Time per Employee per year = 1111.9 Hrs.
= (1112 Hrs. Approximately)

NO. OF GROUPS	NAME OF GROUPS	NO. OF EMPLOYEES A	TOTAL PRODUCTIVE[1] TIME PER EMPLOYEE HRS. B	TOTAL AVAILABLE[2] TIME PER EMPLOYEE HRS. C=1533-B	PRODUCT.[3] TIME ABOVE AVERAGE HRS. D=B-1112	TOTAL PRODUCT. TIME ABOVE AVERAGE FOR THE GROUP HRS. E=A x D	TOTAL PRODUCT. TIME PER GROUP HRS. F=A x B	THEORETICAL NUMBER[4] EMPLOYEES REQUIRED G= F/1112
1	AUTO. SYSTEMS CONTROL GROUP	4	1225	308	113	452	4900	4.4
2	ACQ. RECEIPT OF ORDERS	2	1194	339	82	164	2388	2.1
3	ACQ. ARRIVAL OF BOOKS	4	1056	477	-56	-224	4224	3.8
4	ACQ. SEARCHING	10	1131	402	19	190	11310	10.2
5	MONOGRAPHIC SERIES	5	1008	525	-104	-520	5040	4.5
6	GIFTS AND EXCHANGE	5	893	640	-219	-1095	4465	4.0

(Continued)

---

1 Total Time currently spent in productive works per Employee = Percent Productive Time (Table VII, Table VIII) x 1538.

2 The Total Productive Time available to the employees (after reduction of the hours lost due to vacation etc. and due to the unavoidable personal delays from the total 2028 hours) is 1533 hours. (Please refer to page 31).

Therefore available time for extra work = 1533 - Present Productive Time

These are the number of hours which can be utilized in undertaking further load by each employee in each section with the present pace of work.

3 Productive Time Above Average = (To al Productive Time) - 1112

= +ve if above average

= -ve if below average

4 Total Productive Time per Group/1112 = Theoretical number of Employees based upon the present level of activity.

TABLE IV. NUMBER OF EMPLOYEES REQUIRED IN EACH SECTION OF THE CATALOG DEPARTMENT. (BASED UPON CURRENT LEVEL OF PRODUCTIVE ACTIVITY)

Average Productive Time per Employee per year = 1111.9
= (1112 Hrs. Approximately)

NO. OF GROUPS	NAME OF GROUPS	NO. OF EMPLOYEES A	TOTAL PRODUCTIVE[1] TIME PER EMPLOYEE HRS. B	TOTAL AVAILABLE[2] TIME PER EMPLOYEE HRS. C=1533-B	PRODUCT.[3] TIME ABOVE AVERAGE HRS. D=B-1112	TOTAL PRODUCT. TIME ABOVE AVERAGE FOR THE GROUP HRS. E=A x D	TOTAL PRODUCT. TIME PER GROUP HRS. F=A x B	THEORETICAL NUMBER[4] EMPLOYEES REQUIRED G= F/1112
1	CATALOG DEPT. SEARCHING	2	1113	420	1	2	2226	2.0
2	SOCIAL SCIENCE	4	1087	446	-25	-100	4348	3.9
3	SLAVIC	1.5	992	541	-120	-180	1488	1.3
4	HUMANITIES	3.5	995	538	-117	-409	3483	3.1
5	SCIENCES	3	1142	391	30	90	3426	3.0
6	ROMANCE	3	1230	303	118	354	3690	3.3
7	GERMANIC	2	1071	462	-41	-82	2142	1.9
8	MUSIC	1	1238	295	126	126	1238	1.1
9	FINE ARTS	1.5	1193	340	81	120	1789	1.6

CATALOGING (Continued)

NO. OF GROUPS	NAME OF GROUPS	NO. OF EMPLOYEES A	TOTAL PRODUCTIVE[1] TIME PER EMPLOYEE HRS. B	TOTAL AVAILABLE[2] TIME PER EMPLOYEE HRS. C=1533-B	PRODUCT.[3] TIME ABOVE AVERAGE HRS. D=B-1112	TOTAL PRODUCT. TIME ABOVE AVERAGE FOR THE GROUP HRS. E=A x D	TOTAL PRODUCT. TIME PER GROUP HRS. F=A x B	THEORETICAL NUMBER[4] EMPLOYEES REQUIRED G=F/1112
10	SOUTHEAST ASIA	5	1348	185	236	1180	6740	6.0
11	EAST ASIA	5	1193	340	81	405	5965	5.4
12	SOUTH ASIA	1.5	978	555	-134	-201	1467	1.3
13	CATALOGING MAINTENANCE GROUP	8	1105	428	-7	-56	8840	8.0

1, 2, 3, 4 are explained in the footnotes to Table III.

During the period of this study, June 1974 to December 1974, the Technical Services was processing about 6789 titles per month. The study shows that if full advantage were taken of the available productive capability, 9302[1] titles per month could be processed. It is unlikely in the present economic situation that this volume will be purchased. Therefore the problem is one of combining capabilities and adjusting staffing and work allocations to the sections according to the actual acquisitions level.

Two possibilities exist here:

Assuming extreme economic pressure, one possibility is to cut back in every section to the actually required number. The alternative is to accept attrition as it occurs and attempt to balance the work to this level. The following analysis is illustrative of the computations and work assignments required. It is based on the current average level of productive activity throughout the technical services (=1111.9 hours per employee per year).

As attrition occurs the staffing of the sections can continue to be balanced as the productive time required by the acquisitions volume increases to the limit of 1533[2] hours/year/person.

---

[1] About 37% more than the present cataloging level.

[2] 1111.9 + 421.1 = 1533 hours (See page 26)

Dividing the total number of productive hours of each group in the three Departments by the average number of hours employees throughout Technical Services engage in productive work (=1112 hours approximately, Table 2), we get the theoretical number of employees required in each group, assuming all work to the current level.

Table III and Table IV compare the number of employees in each section of the ASCG, The Acquisitions and Catalog Departments, with the number of employees actually needed. Ideally, the groups, which need more employees than are actually working in their section, must share a part of their work with those having more than the required number of employees. This sharing must be so conducted that all employees must have their hourly contribution towards productive work as close to the average of the three Departments (= 1112 hours per year) as possible. In some instances it is, however, very difficult to achieve. The South East Asia and the East Asian sections of the Catalog Department need 6 and 5.4 full time equivalent employees respectively. Each of them has only 5 full time equivalent employees working in the groups. (These groups include the Searchers of their fields also). Since the processing of books in these sections need the knowledge of the Asian Languages, employees from other sections cannot readily be asked to share the work in these sections.

The South Asian and the Slavic Language sections have 0.2 full time equivalent employees excess in each section. Employees from these sections can easily be trained to share the work in other groups. The South Asian may possibly work in collaboration with the South East Asian section, to share some of their work also.

The Searchers in the Catalog Department, the Sciences and the Catalog Maintenance Groups have the exact number of employees required in their sections.

One of the employees in the Humanities group helps Fine Arts also. The Humanities have 0.4 full time equivalents in excess. If they share some of the duties of the Romance Languages Group which needs 0.3 full time equivalents, the work in these sections will smooth out.

The Slavic can help the Music or the Fine Arts.

Gifts and Exchanges have 1 full time equivalent employee in excess and she can easily be transferred to other sections of the Technical Services.

In the Acquisitions Department and the ASCG, it is recommended that 1/2 full time equivalent employee from the Monographic Series Section be asked to assist the ASCG for about 15 to 16 hours a week and to help for the typing or mailing of orders for about 4-5 hours a week.

The section responsible for the books upon arrival from the dealer, may be asked to help the Searchers in Acquisitions for about 7 to 8 hours per week.

With the pattern of work changed as recommended above, it is anticipated that each employee in the three departments will share nearly equal burden of duties in terms of time devoted to the productive work.

A second problem is the seasonal variation in the number of items to be processed in total and among the sections. This requires advanced scheduling based on the volume of orders and the lagged volume of Acquisitions and Cataloging so as to insure proper balance among sections and adequate ability to handle higher volumes of work during the peak months.

For example, the report shows that if 1000 volumes are to be cataloged, this will require about 650 hours of work.

RECOMMENDATION FOR A SINGLE SEARCHING UNIT FOR THE ACQUISITIONS AND CATALOG DEPARTMENTS

When orders are searched in the Acquisitions Department, the searchers encounter information in the card catalog and on the OCLC terminals that would be useful to the Catalog Department. They do not record this information, but instead it is found and recorded later by searchers for the Catalog Department.

Since the positions in the two departments are basically equivalent, it is recommended that all searchers be combined into one unit. The information for both the Acquisitions and Catalog Departments will be recorded at the time of the initial search and the second search will be eliminated thereby saving time. The pooling of the labor for the two units will also provide greater flexibility for both Cataloging (2 searchers) and Acquisitions (8 searchers). Additional workload due to illnesses and vacations could be better absorbed by the larger group, and the language capabilities of the group could be broadened and strengthened. On the whole, operations should be smoother and more efficient in both Cataloging and Acquisitions.

RECOMMENDATION TO TRANSFER THE INFORMATION OF OLD CATALOG TO NEW CATALOG

The Old Card Catalog contains the bibliographic information about the books published prior to 1948.

During the process of searching to get information about an old book, the searchers have to review the Old Catalog cards to check if any information is available there. Rarely, do they find the information available. One of searchers has been able to find only two titles during the last 18 months.

The information in the Old Catalog also is provided in a slightly different pattern than the new. This creates certain procedural difficulties in the searching pattern.

Two searchers in the Acquisitions Department can easily devote time to transfer the Old Catalog information to the Card Catalog without disturbing the balance of the present searching rate. Once the information is completely transfered, it will help the searchers to go only to one Catalog and follow only one procedure to attain the information they need. It will cut down the time and the possibility of overlooking a card which contains the information of the old material being searched, especially when the searcher is newly trained.

RECOMMENDATION FOR GETTING COMPLETE INFORMATION FOR THE REQUESTED ITEMS

The difficulties involved in the searching operation in Acquisition Department can be considerably reduced if complete information is provided to the Searchers right in the beginning.

The Olin Library and the departmental libraries have certain cards which must be filled out for each item ordered. These cards need to provide space for some additional information such as the names of co-authors and the L.C. Card Number etc.

Then, instead of keeping these cards in the libraries, they must be distributed in the form of small packets having 20-25 cards each to all those Faculty Members who send orders for the various materials each year. A circular should also be sent along with the packet to the Faculty Members telling them the importance of those cards, showing them how they could obtain the information and what each item means, and requesting them to fill in the card as completely as possible.

Knowing the type of information needed by the Library, they will provide as much information as they can. This will help the Searchers considerably in the speeding up of their work.

REASONS FOR UNEVEN WORKLOADS

1. The ordering pattern of those individuals responsible for the selection of monographic materials is erratic. This creates a wave effect throughout the system which results in high and low work loads.

2. There are some factors of highest priority which occur randomly.

   a) Rush orders: Whenever a book is immediately needed by an Faculty staff or departmental librarians rush orders are sent to the Acquisitions Department. Rush orders are usually sent just prior to the beginning of a semester.

   b) Catalogs of Antiquarians: Some dealers send a list of available rare books (usually second hand books). These catalogs may arrive in the library at any time of the year. They have to be given highest priority because the rare books available may go out of stock almost immediately.

3. The end of fiscal year and the start of the semester also effects the work load. This effect is periodical, work load goes up at the start of semester and slowly fades down at the end. At the end of fiscal year, the remaining budget is used up before the year ends.

Benefits, that can be achieved by smoothing the work load, are:

1. The psychological pressure on the searchers, that is built up due to the magnitude of work, can be avoided. It shall decrease the probability of making avoidable errors due to the pressure of work.

2. Better planning can be done and a better utilization of the time of the searchers can be achieved, which is otherwise wasted during periods of low work load.

It is recommended that the Departmental Librarians be requested to provide the list of orders on a more or less regular basis and the individuals responsible for reviewing orders pass on that information on a daily or weekly basis to the Acquisitions Department.

PROPOSAL FOR A NEW LAYOUT

An average walking time between the Cataloging and Acquisitions Department is determined to be 3.1% of the total time (=2028 hours). The average walking time between the Acquisitions and the Card Catalog is found to be 4.8%. (Table VII)

If the Acquisitions Department is brought adjacent to the Catalog Department the distance between those two departments would be about one-fourth of the present distance and the distance between the Card Catalog and the Acquisitions Department will be half as much.

This will cut short the time wasted in walking between the Acquisitions and the Catalog Department by

(3/4) x (3.1 x 1538 x 4/100) = 143 hrs.

The time wasted in walking between the Acquisition Department and the Card Catalog would be nearly

(1/2) x (4.8 x 1538 x 10/100) = 369 hrs.

for each of the 10 searchers.

A Total Savings of 143 + 369 = 512 hrs.

can then be accomplished.

This new layout will also enable the searchers of the Acquisitions Department to be seated near the terminals for the searching of the titles in OCLC data base.

EFFICIENCY OF KEYPUNCH OPERATORS

During September, October and November 1974, 34,340 cards were keypunched with about 40 key-strokes for each card, 27,580 cards with 42 key-strokes and 39,788 with about 25 key-strokes for each.

Total number of key-strokes

= (34,340 x 40 + 27,980 x 42 + 39,738 x 25) = 3543460

Standard Number of key-strokes per keypunch operator per hour	=	5500 (1)
Standard time required to keypunch 3543460 times = 3543460/5500	=	644.27 Hrs.
From work sampling study the group of 4 full-time equivalent employees devotes 41.8% of the total time to keypunching. Total number of hours with the group during the 3 months = 2028 x 4/4	=	2028 Hrs.
Number of hours of leave actually taken by the group during the 3 months	=	172 Hrs.
Total time available for work = 2028-172	=	1856 Hrs.
Total time devoted to keypunching = 1856 x 0.418	=	775.3 Hrs.
Efficiency of the keypunching operators = (644.27/775.8) x 100	=	83.06%

[1]Personal interview with Mr. J.W. Rudan , Director of the Office of Computer Services.

As the keypunching operators need to keypunch the names of the authors and titles of books in foreign languages also and both the alphabetic and numeric letters have to be keypunched together very frequently, this efficiency may be considered quite high. It is believed that the efficiency will still increase as the load on the operator increases.

RECOMMENDATION FOR FUTURE STUDY

As mentioned on page 10, when the monographs are searched on the OCLC terminals in the Catalog Department, those which are not found in the data base are searched again after a month. The ones which are still not found in the data base are again kept for a month and a third and final search is made.

These monographs which are found in the data base in any one of the three searches are given immediately to the Catalogers for L.C. Cataloging or for Cataloging with member copy. The rest of the titles are given to the Original Catalogers.

It has yet to be determined whether waiting for two months to get about 85% (please see footnote on page 49) of the titles cataloged by Library of Congress or by one of the Member Libraries really brings the cost of the whole operation (Searching and Cataloging) down to a minimum without losing any efficiency.

The use of the information about a title in the data base costs the Central Technical Services 85 cents. Original Catalogers devote about 29.3 minutes for a title (Table VI, Appendix I), or roughly two titles are cataloged per hour. The wage of an Original Cataloger is about $5.4 per hour. Thus, the labor cost of the Original Cataloging is about $2.7. per title.

About 4 titles are L.C. Cataloged per hour and the average wage of L.C. Cataloger is $3.4 (Table VI). The labor cost of L.C. Cataloging comes to about ($3.4/4=) 85 cents.

Ignoring the cost of Member Copy Cataloging at this moment, (very few titles have member copy as compared to those which have L.C. copy in the data base) there is a net savings of about ($2.7-0.85-0.85=) $1.0 on each title found on the terminal in the initial search.

For those titles which are kept for a month or two, however, the cost of keeping the inventory must be added. The cost of delaying the use of the book is also an important figure which must be found out. When these costs add up to more than $1.0 the book must then be given to the Original Cataloger without any further delay.

A detailed study in this direction is needed. It is anticipated that great saving in time and the value of the book otherwise lost in delay can be achieved if the break even point is known accurately.

APPENDIX I.

RESULTS OF TIME AND COST STUDY

A. Determination of the cost of processing a monograph of Social Sciences classification in each section of the Central Technical Services of Olin Library.

The incremental cost of handling and processing the monographs was determined for each of the following areas:

1. Shipping Room
2. Acquisition Department
3. Automated Systems Control Group
4. Acquisitions and In-Process Control System
5. Cataloging Department
6. Cataloging Support System (OCLC)
7. Marking and Plating Section
8. Binding Section

The cost of processing a monograph was found by totaling the incremental costs incurred to the Library in departments 1 thru 7. Only a part of the total monographs processed, required binding. Those which need binding are sent to a bindery outside the University. The cost of preparation of a monograph for the bindery and the check-in upon arrival is also determined and given separately.

In each case a number of monographs or other relevant matter were collected over a certain period of time and the process time was noted by the employees and results given to me. In case of keypunching and verification, I timed the work myself to obtain the process time. Knowing the average

wage of the employees in a given section, the average cost of processing a monograph in that section was found.

1. Shipping Room

Sample size (n)	= 250
Time required (noted by employees)	= 75 min.
Average process time	= 0.005 hrs. per monograph
Average wage of workers	= $4.0625 per hour
Average Shipping Room Cost	= $4.0625 x 0.005 = $0.0202 per monograph

2. Acquisitions Department

a) Labor Cost

Monographs were collected over a period of about two weeks. The sample contained monographs both with Title II cards and with AQII forms.

Sample size of monographs with Title II (n_1)	= 129
Sample size of monographs with AQII (n_2)	= 113
Total Sample size ($n_1 + n_2$)	= 242

The table on next page gives the breakdown of the total time and the cost of processing a monograph in the Acquisitions Department.

TABLE V. ACQUISITIONS DEPARTMENT COST

ACQUISITION TASKS	WAGE $ HR.	TITLE II (129 ITEMS) TIME HRS.	TIME/ MONO.	COST $	AQ II (113 ITEMS) TIME HRS	TIME/ MONO.	COST $	TOTAL AVE. (242 ITEMS) AVE. TIME /MONO.	COST $
PREPARE CARDS FOR SELECTION & XEROX	3.070	1.1727	0.0091	0.0279	0	0	0	0.0048	0.0147
BATCH, ALPHABETIZE, SEND DUPLICATES TO LIBRARIES	3.070	0.5863	0.0045	0.0140	0	0	0	0.0023	0.0070
SEARCH	3.074	5.5833	0.0432	0.1326	8.8333	0.0781	0.2400	0.0595	0.1829
REVISE & DEALER ASSIGNMENT	5.820	0.9000	0.0069	0.0401	1.4000	0.0123	0.9715	0.0095	0.0552
SERIES SEARCHING & REVISING	4.750	9.4041	0.0729	0.3462	5.8421	0.0517	0.2455	0.0628	0.2983
EDITING	2.880	0.9166	0.0071	0.0204	0.3333	0.0073	0.0210	0.0072	0.0207
FILE ORDER & SEARCH FORMS	2.250	-	-	-	-	-	-	0.0032	0.0184
ORDERS MAILED	3.880	-	-	-	-	-	-	0.0045	0.0174
BOOKS RECEIVED	3.490	-	-	-	-	-	-	0.0258	0.0900
PULL ORDER & SEARCH FORM	2.250	-	-	-	-	-	-	0.0173	0.0389
REVISE BOOK SEARCH COPY	3.150	-	-	-	-	-	-	0.0392	0.1234
FUND & FLYER BOOKS	3.880	-	-	-	-	-	-	0.0250	0.0970

Acquisitions Department Cost per monograph = $0.9639

b) Material Cost

Cost of Material and Xeroxing in Acquisitions Department is also determined by adding the average costs for AQII forms, Xerox paper and the cost of xeroxing a sheet for a number of titles and averaging it for one title.

Total Cost of (Material + Xerox + AQ2 form) per monograph = $0.0208

3. Automated Systems Control Group (A.S.C.G.)

a) Labor Cost

Sample Size (n)	= 253
Total Time for Keypunching (554 + 528) 1082 cards belonging to 253 titles	= 4.75 hrs.
Total time for verification of the 1082 cards keypunched	= 1.70 hrs.
Total time for keypunching and verification	= 6.45 hrs.
Average wages of the keypunch operators and verifiers	=$3.50 per hour
Average cost of keypunching and verification = (6.45)(3.5)/253	=$0.0892 per title

b) Equipment Cost

Yearly cost of renting 3 keypunching machines	=	$2,974.32
Yearly cost of renting 1 verifier	=	947.28
Total yearly cost of renting machines	=	$3,921.60
Total material to be processed in Olin	=	52.199[1]
Average cost of equipment = $\frac{3921.60}{52199}$	=	$0.0751

4. Acquisitions and In-Process Control System

Annual Systems Cost	=	$68000.00
Material to be processed	=	52199.00
Average Cost = 68000/52,199	=	$1.3027

5. Cataloging Department

i) Searching Cost: Based upon the figures that ILR[2] titles found in initial search are 46.3%, in second search 9.6% and in third search 4.3% and the time for a single search is 0.8 minutes.

Average time for searching a monograph	=	1.5837 min.
Average wage of a searcher	=	$3.02
Average cost of searching a monograph	=	$0.0797

---

1 This figure is taken from the 1973/74 Annual Report of the Automated Systems Control Group, and it represents the number of records entered into the Acquisitions and In-Process Control System.

2 These figures are for ILR library. As for the Central Technical Services for Olin Library, the number of titles found in initial search is 65.8%, in second search is 13.3% and in the third search is 6.1%. 14.8% are Original Cataloged. (Based upon the past data, February 6 to March 25, 1974).

ii) Cataloging Cost

The output of the original and L.C. catalogers of the Social Sciences Section of the Cataloging Department was studied for two weeks. The time required to perform the 'desk work' and the 'terminal work' was noted by the Catalogers for each monograph. In case a monograph needed original cataloging, the time required for 'proofreading' was also noted.

A PL/C program was written and used to compute the mean process time, standard deviance, sample variance and intervals for 90, 95 and 99% confidence levels[1] for each type of cataloging and for each step involved.

Sample Size for L.C. Cataloging (n_1)		= 291
Sample Size for Original Cataloging (n_2)		= 80
Sample Size for Cataloging with Member Copy (n_3) (collected during 2 weeks)	= 18	
Added numbers of titles with member copy to increase sample size	= 40	
Total Sample size for Cataloging with Member Copy (n_3)	= 58	= 58

The results are given on the following page.

---

1 See Appendix V for the program and the results.

TABLE VI. CATALOGING DEPARTMENT LABOR COSTS

I. L.C. CATALOGING		TIME (min.)	WAGE $/HR.	COST $/MONO.
1)	DESK WORK	9.66	3.415	0.5498
2)	OCLC TERMINAL	3.83	3.415	0.2179
	TOTAL	13.49		0.7677

II. ORIGINAL CATALOGING		TIME (min.)	WAGE $/HR.	COST $/MONO.
1)	DESK WORK	26.26	5.445	2.3830
2)	INPUT	6.05	3.283	0.3310
3)	PROOF READING	3.05	5.445	0.2767
	TOTAL	35.36		2.9907

III. MEMBER COPY CATALOGING		TIME (min.)	WAGE $/HR.	COST $/MONO.
1)	DESK	14.75	5.445	1.3385
2)	TERMINAL	6.18	5.445	0.5608
	TOTAL	20.93		1.8993

AVERAGE COST OF CATALOGING

Number of member titles in sample = 18

Number of Original titles = 80

Total (given to Original Cataloger) = 98

Average cost of Original cataloging per monograph = (1.8993 x 18/98 + 2.9907 x 80/98)
= 0.3438 + 2.4413 =$2.7901

Average cost of L.C. cataloging a monograph =$0.7677

Given the 60% are L.C. cataloged and 40% are original.

Average cost of cataloging a monograph
= (0.6 x .7677 + 0.4 x 2.7901)
= 0.4606 + 1.1160 =$1.5766

6. Cataloging Support System (OCLC)

The cost of the cataloging support system is given below:

1.	Terminal lease	$4800
2.	Maintenance contract (4 x $39/mo. x 12 mo.)	1872
3.	Line charges ($211.6/mo. x 12 mo.)	2660
4.	Data Set ($55/mo. x 12 mo.)	660
5.	C2 conditioner ($28/mo. x 12 mo.)	336
6.	Telephone equipment ($16.5/mo. x 12 mo.)	198
		$10526

It is anticipated that Olin will process about 45,000 books on the system next year.

Cost of cataloging support system per monograph = 10526/45000	=	$0.2339
Cost of OCLC information per monograph (Assuming 60% L.C. cataloged) = 0.85 x 0.6	=	0.5100
Cost of production of 20 cards for each title = (0.35)(20)	=	0.7000
		$1.4439

7. Marking and Plating Sections

i. Cost of Marking and Plating

a. Labor cost of Marking

Sample size (n)	=	300
Time required for marking	=	331 minutes
Average time for marking	=	1.1 minutes
Average cost for marking	=	\$2.77 x 1.1/60 = \$0.0507

b. Labor Cost of Plating

Sample size (n)	=	200
Time required for plating	=	92 minutes
Average time for plating	=	0.46 minutes
Average cost for plating	=	\$2.77 x 0.46/60 = \$0.0212

c. Material cost for Marking and Plating

Cost of the strip used for Marking	=	\$1.40
Number of labels per strip	=	100
Cost of material per monograph	=	\$0.0140

ii. Cost of Binding

Those monographs which need binding are sent to a bindery which charges the Technical Services of a prescribed rate. Only pamphlets are bounded within the Library.

a) Labor Cost for preparation to bindery and check in upon arrival.

Number of monographs prepared for bindery	=	20 per hour
Average time	=	3 minutes per monograph
Number of monographs checked in	=	35 per hour
Average time	=	1.7 minutes per monograph
Average time for preparation to bindery and check in upon arrival	=	4.7 minutes
Labor Cost = 4.7 x 3.106/60	=	$0.2433

b) Labor Cost of pam-binding (pamphlet binding).

Sample Size (n)	=	76 pamphlets
Time required for pam-binding	=	210 minutes
Average time for pam binding	=	2.7631 minutes
Average cost for pam binding = 2.7631 x 3.106/60	=	$0.1430

c) Material cost for pam-binding.

Cost of a pam-binder	=	$0.2199

B. Overhead Costs

	Percentage of direct labor cost
Administrative overhead, space, materials, accounting, lighting, general maintenance	= 21% (1)
Fringe benefits and salary administration	= 16% (2)
	TOTAL= 37%

1 Ferdinand F. Leimkuhler & Michael D. Cooper, "Cost Accounting for University Libraries", College and Research Libraries, v. 32, 1971, pp. 449-464.

2 This is the percentage used by Cornell University when determining the cost of Fringe benefits and salary administration for each worker.

APPENDIX II

RESULTS OF THE WORK SAMPLING STUDY

AMOUNT OF TOTAL AVAILABLE TIME DEVOTED TO EACH ACTIVITY

Tables on the following pages are the results of the Work Sampling Study. The fraction of the total available time of the employees, devoted to various productive and non-productive activities is given for each group in the ASCG, the Acquisitions and the Catalog Departments. All the figures are in percentages based upon the available time 1538 hours per year.

The desk work includes typing, writing, reading and concentrating in work. Training, Getting Trained or Consultation represents the time spent in these activities and All Others include the other productive activities such as the key-punching and verification time for ASCG.

The Avoidable Delays do not include the extra fifteen minutes delay after the coffee break before the resumption of work and the Card Catalog includes both the new and the Old Catalog.

The total productive and non-productive times are also given.

The productive time ratio is obtained using an average figure of total productive time for each group in each department and is given on page 63.

TABLE VII. PERCENT OF TOTAL AVAILABLE TIME DEVOTED TO PRODUCTIVE AND NON-PRODUCTIVE ACTIVITIES IN AUTOMATED SYSTEMS CONTROL GROUP AND THE ACQUISITIONS DEPARTMENT

NO.	NAME OF GROUPS	NO. EMPLOYEES	WALKING TIME	DESK WORK	CARD CATALOG	SHELF LIST	OCLC TERMINAL	TRAINING GET TRAIN CONSULTING	ALL OTHERS	TOTAL PRODUCTIVE TIME	AVOIDABLE DELAYS AND OTHERS	PERSONAL DELAYS (5-7%)	TALKING	TOTAL NON-PRODUCTIVE
1	AUTO. SYSTEMS C.GROUP	4	-	9.8	-	-	-	7.7	62.2[1]	79.7	8.8	3.3	8.2	20.3
2	ACQ. RECEIPT OF ORDERS	2	-	42.4	-	-	-	12.0	23.0	77.6	15.1	1.4	6.1	22.6
3	ACQ. ARRIVAL OF BOOKS	4	7.8[2]	24.4	-	-	-	9.4	27.1	68.7	15.7	6.3	9.3	31.3
4	ACQ. SEARCHING	10	6.1[3]	22.2	17.7	-	2.0	6.0	19.6	73.6	12.7	6.1	7.6	26.4
5	MONO. SERIES	5	3.9	34.2	5.8	2.9	-	16.1	2.7	65.6	11.1	8.3	15.0	34.4
6	GIFTS AND EXCHANGES	5	5.3	28.9	8.1	1.9	-	11.1	4.8	58.1	15.3	14.1	12.5	41.9

(continued)

[1] Time for key-punching	=	41.8%
Time for verification	=	13.4%
TOTAL	=	55.2%

Remaining (62.2 - 55.2 =) 7.0% of the time is spent in other productive work such as arranging the computer cards, the computer lists and the books being processed.

[2] Average time spent in walking between Acquisitions and Catalog Departments	=	3.1%
Average walking time to and from other Sections of Library	=	4.7%
TOTAL	=	7.8%

[3] Average time spent in walking between Acquisitions and Card Catalog	=	4.8%
Average Walking time to and from other Sections	=	1.3%
TOTAL	=	6.1%

TABLE VIII. PERCENT OF TOTAL AVAILABLE TIME DEVOTED TO PRODUCTIVE AND NONPRODUCTIVE ACTIVITIES IN THE CATALOG DEPARTMENT

NO.	NAME OF GROUPS	NO. EMPLOYEES	WALKING TIME	DESK WORK	CARD CATALOG	SHELF LIST	OCLC TERMINAL	TRAINING GET TRAIN CONSULTING	ALL OTHERS	TOTAL PRODUCTIVE TIME	AVOIDABLE DELAYS AND OTHERS	PERSONAL DELAYS (5-7%)	TALKING	TOTAL NON-PRODUCTIVE
1	CAT. SEARCHING	2	4.9	15.9	6.5	8.0	31.1	2.4	3.6	72.4	15.8	6.2	5.6	27.6
2	CAT. SOC. SCI.	4	4.8	26.7	3.7	4.7	6.7	18.5	5.6[1]	70.7	12.6	7.8	8.9	29.3
3	SLAVIC	2	1.4	43.9	2.9	12.8	-	3.5	-	64.5	23.1	3.5	8.9	35.5
4	HUMAN ITIES	3	4.4	24.9	4.4	4.5	11.3	8.8	5.9	64.7	13.3	11.8	10.2	35.3
5	SCIENCES	3	4.7	32.3	13.3	7.6	9.5	5.7	1.0	74.3	6.6	7.7	11.4	25.7
6	ROMANCE	3	4.4	35.2	6.4	3.9	9.1	9.1	6.9	80.0	8.8	5.6	5.6	20.0
7	GERMANIC	2	-	39.6	14.2	5.0	4.7	3.1	3.1	69.7	20.6	-	9.7	30.3
8	MUSIC	1	1.9	42.2	7.8	11.5	9.5	5.7	1.9	80.5	11.7	3.9	3.9	19.5
9	FINE ARTS	1	3.6	35.4	16.1	12.9	6.4	3.6	-	77.6	12.8	-	9.6	22.4

Continuation.

NO.	NAME OF GROUPS	NO. EMPLOYEES	WALKING TIME	DESK WORK	CARD CATALOG	SHELF LIST	OCLC TERMINAL	TRAINING GET TRAIN CONSULTING	ALL OTHERS	TOTAL PRODUCTIVE TIME	AVOIDABLE DELAYS AND OTHERS	PERSONAL[2] DELAYS (5-7%)	TALKING	TOTAL NON-PRODUCTIVE
10	SEA	5	2.8	62.7	3.3	3.3	-	2.2	13.4	87.7	7.6	1.2	3.6	12.3
11	EAST ASIA	5	3.2	42.1	-	9.1	-	17.1	6.1	77.6	10.8	6.2	5.4	22.4
12	S. ASIA	1.5	7.9	30.6	2.0	6.1	-	5.1	21.9	63.6	25.4	8.0	3.0	36.4
13	CATALOG INPUT GROUP	8	6.1	42.5	8.2	-	15.1	-	=	71.9	6.6	11.6	9.7	28.1

[1] Time for Productive Work at other location = 2.7%
Time for some Undefineable productive works = 2.9%
Total = 5.6%

[2] Average time spent in personal unavoidable delays = 6.91% of the total available time in library.
= 6.91 x 1538/2028 = 5.23% of total time per year.

PRODUCTIVE TIME RATIO (PTR)

The averages of the Productive Times (obtained from Tables VII, VIII), based on the available 1538 hours for Productive Work for ASCG, the Acquisitions and the Catalog Departments are given below.

Average Productive Time for the Automated Systems Control Group (Table VII) = 79.7%

The average values of Productive Time for the Acquisitions and the Catalog Departments are based upon the number of employees in each section in the two departments.

Average Productive Time for the Acquisitions Department = (2 x 77.6 + 4 x 68.7 + 10 x 73.6 + 5 x 65.6 + 5 x 58.1)/26
= (155.2 + 274.8 + 736 + 328+290.5)/26 = 68.63%

Average Productive Time for the Catalog Department = (2 x 72.4 + 4 x 70.7 + 2 x 64.5 + 3 x 64.7 + 3 x 74.3 + 3 x 80.0 + 2 x 69.7 + 1 x 80.5 + 1 x 77.6 + 5 x 87.7 + 5 x 77.6 + 3 x 63.6 + 8 x 71.9)/42 = 73.88%

The overall average of the Productive Time for the three departments, based upon available 1538 hours per year =(79.7 x 4 + 68.63 x 26 + 73.88 x 42)/72 = 72.3%

Productive Time Ratio (PTR) is based upon the total number of hours employees are paid for in a year (=2028 hours)

PTR for ASCG = 79.7 x 1538/2028 = 60.4%

PTR for Acquisitions Department = 68.63 x 1538/2028 = 52.0%

PTR for Catalog Department = 73.88 x 1538/2028 = 56.0%

PTR for the three departments combined (also shown in Table II) = 72.3 x 1538/2028 = 54.8%

SPOT CHECKING

While taking observations I could be noticed by the employees during the work sampling study. It was desireable therefore, to determine the extent to which their work pace changes when I was not taking the observations. Spot checks were made for that purpose on 12 persons selected arbitrarily from the Acquisitions and Catalog Departments. Each time I entered the work area I noted whether the persons under observation were doing productive or non-productive work.

Thirty-two sets of observations on all the 12 persons indicated that they were all doing productive work in 147 instances of observation and non-productive work in 99, giving a total of 246 observations.

$$\text{Productive Time Ratio (Spot Checking)} = \frac{147}{246} \times 100 = 59.7\%$$

$$\text{At 95\% confidence level Sample Error} = \pm 1.96 \times \sqrt{\frac{(0.597)(1-0.597)}{246}}$$

$$= 0.06076$$

$$= \pm 6.076\%$$

For the same 12 individuals the Productive Time Ratio from Work Sampling is.

1.	54.3%	4.	78.4%	7.	69.8%	10.	72.1%
2.	58.1%	5.	52.1%	8.	58.6%	11.	50.9%
3.	70.6%	6.	62.3%	9.	61.8%	12.	56.1%

Average = 62.09% as opposed to the spotcheck result = 59.7%

The comparison of the two results indicates that the results of Work Sampling are well within the range of the results of Spotchecks which have the 95% confidence interval for PTR equal to (53.7, 66.7). This shows that my presence was not affecting the pace of the work of the employees to any appreciable degree and that the Work Sampling results are highly reliable.

APPENDIX III.

MARKOV CHAIN ANALYSIS

Using the data available from the Work Sampling Study, 10 sets of consecutive observations were selected at random for the searchers in the Acquisitions Department. The complete work performed by each searcher was classified into three broad states of work as the Desk Work (DW), Other Productive Work (OPW) and All Non-Productive Works (NPW)

As the time of each set of observations was known, the state of the work of each searcher at any one of the observations and in the next transition (next observation) could be determined.

Assuming that the transition from one state to another depends only on the present state and not on the past history of transitions, we can model the behavior of the searchers in terms of a Markov Chain, which has discrete parameter space (instants of time when observations were made) and discrete state space (the 'Desk Work', 'Other Productive Work', and the 'Non-Productive Work')

The probability of transitions from one state to another can then be obtained from the observations. The transition probability matrix is formulated and is given on next page.

TRANSITION PROBABILITY MATRIX

		DW	OPW	NPW
	DW	0.312	0.350	0.338
P_1=	OPW	0.182	0.534	0.284
	NPW	0.188	0.711	0.101

The remultiplication of P_1 by itself gives the transition probabilities at next transition. The final stationary distribution which has all its elements in the same column equal is as follows:

FINAL MATRIX FOR THE STATIONARY DISTRIBUTION

		DW	OPW	NPW
	DW	0.210	0.539	0.269
$(P_1 x..x\ P_1)=P_n$=	OPW	0.210	0.539	0.269
	NPW	0.210	0.539	0.269

Limiting probabilities for the states are:

Desk Work $= \pi_1 = 0.210$

Other Productive Work $= \pi_2 = 0.539$

Non Productive Work $= \pi_3 = 0.269$

This implies that in the long run the searchers group shall be performing,

Desk work for 21.0% of their time.

Other productive work for 53.9% of their time, and

Total non-productive work 26.9% of their total time.

This is in a remarkable agreement with the work sampling results, which show the time for Desk Work = 22.2%, other productive work = 52.64%, and non productive work = 26.4%

Since the two results are so close we can easily conclude that during the period of this study when samples (observations) were taken the process of searching had passed the initial run in period and had attained stability. During this period the work was smooth without any significant fluctuations.

APPENDIX IV

COMPARISON OF RESULTS BY TIME STUDY AND BY WORK SAMPLING STUDY

A) COMPARISON OF THE WORK ACTIVITIES IN THE ACQUISITIONS DEPARTMENT BY THE TWO METHODS

1. RECEIPT OF ORDERS

Time Study

Time needed to process a unit is as follows (Table V):

Time to Revise and Assign Dealer	=	0.0095 Hrs.
Time to File Order	=	0.0082 Hrs.
Time to Mail Orders	=	0.0045 Hrs.
Total Time	=	0.0222 Hrs.
	=	1.33 minutes

Work Sampling

Average time available from two employees in two months (Table I) = 128 x 2 x 2 = 512.00 Hrs.

Number of materials processed in September and October 1974 = 10,450

Percent of the Available Time for the Desk Work and other productive work for the section which processes the orders received (Table VII) = 42.4 + 23.0 = 65.4%

The two employees in this section devote about one-fourth of their time to many other activities.[1]

The fraction of available time devoted to processing orders = 65.4 x 0.75 = 49.0%

---

[1] These figures are obtained from the Job Description of the two employees.

Time required to process a unit order
= (512 x 0.49)(60)/10450 = 1.44 min.

Difference in the time to process a unit order from the two study, basing on the result obtained from Work Sampling = (1.44 - 1.33) x 100/1.44 = 7.6%

2. SEARCHING

Time Study (Table V)

Time for preparation of cards and xeroxing	=	0.0048	Hrs.
Time for alphabetizing, sending duplicates etc.	=	0.0023	Hrs.
Time for Searching	=	0.0595	Hrs.
Time for Series Searching	=	0.0628	Hrs.
Time for Editing	=	0.0072	Hrs.
Total Time	=	0.1366	Hrs.
	=	8.19	Minutes

Work Sampling

Total available time with the 10 searchers in September and 9 in October 1974
= 128 x 19 = 2432 Hrs.

Percent of available time devoted to work (Table VII) (total productive time-time devoted to training and walking) = 73.6 - 6.0-6.1 = 61.5 %

Time devoted to search and research 10450 titles during the two months
= (2432 x61.5) x 60/10450 = 8.58 Minutes

Difference in the time of Searching a title from

from the two studies=(8.58 - 8.19) x 100/8.58 = 4.5%

3. RECEIPT OF BOOKS

Time Study (Table V)

Time needed to receive a title	= 0.0258
Time needed to pull slips	= 0.0173
Time for revision	= 0.0392
Time needed to fund and flyer books	= 0.0250
Total Time	= 0.1073 Hrs.
	= 6.43 Minutes

Work Sampling

The group has been counting the number of books each person processes per day. An average of about 6 weeks showed that the group processes a total of 140 titles per day.

Total time available for productive work with the 4 employees per day = 128 x 4/21	= 24.3 Hrs.
Time available from the student employee per day	= 4.0 Hrs.
Total Time	28.3 Hrs.

Percent of available time devoted to work (Total Productive Time - time for training and consultation - time in walking)(Table VII)=68.7-9.4-7.8 = 51.5%

Time required to process a title = (28.3 x 0.515 x 60)/140 = 6.24

Difference = $\frac{6.43 - 6.24}{6.24}$ = 3.0%

The comparison shows that in all the cases the results from the two studies are very close. The difference ranges from 3% to 7.6%. We can therefore rely on the results of both the studies. The time study gives the time needed to perform a well defined operation whereas the work sampling throws light on the time required to perform the operation as well as the time needed to accomplish the other undefinable activities which are inherently connected with the completion of the main operation.

B) COMPARISON OF SOCIAL SCIENCES SECTIONS ACTIVITIES BY THE TWO METHODS

As the ILR library acquires monographs mainly in the field of social sciences, we studied the time of cataloging a monograph only in the Social Sciences Section of the Catalog Department, during the Time Study. From the Work Sampling Study we can find the time of cataloging a monograph in each section of the Catalog Department. The comparison of the time of processing a monograph in the Social Sciences Section is given below.

Total number of titles cataloged during September, October and November 1974 by Social Science Catalogers = 2166

1. Time Study

The number of titles cataloged during September, October and November 1974 by the L.C. Catalogers in the Social Sciences Section is 1728, number of those cataloged with member copy is 281, and the number Originally Cataloged is 157. From Time Study (Table VI, Appendix I) the time for L.C. Cataloging is 13.49 minutes, for cataloging with member copy is 20.93 minutes and for Original Cataloging is 35.36 minutes per title cataloged.

Time required for cataloging, during the 3 months is as follows:

		No. Titles	x	Time Per Title	=	Total Time
Time for L.C. Cataloging	=	1728	x	13.49	=	23310
Time for Cataloging with Member Copy	=	281	x	20.93	=	5881
Time for Original Cataloging	=	157	x	35.36	=	5551
		Total Time			=	34742 minutes

Average time per monograph = 34742/2166 = 16.03 minutes

2. Work Sampling

The exact number of hours devoted to work by each person in the Social Sciences Section during the three months is as follows:

TABLE IX: NUMBER OF HOURS WORKED DURING THREE MONTHS

Cataloger No.	Sept.	Oct.	Nov.	Total of Three Months
1	164	180	148	492 Hrs.
2	70	180	141	391 Hrs.
3	(Gone on Maternity leave, about 3 months)			
4	164	172	148	484 Hrs.
5	164	172	149	485 Hrs.
			TOTAL=	1852 Hrs.

PTR for Social Sciences Section based up the Total Available Time (Table VIII Appendix II)	= 70.7%
Time for Training, Getting Trained, Consultation, Walking and other Undefineable Productive Works (Table VIII)= 18.5 + 4.8 + 2.9	= 26.2%
Remaining time for productive work based upon the total available time	= 44.5%

Productive Cataloging Time from Work Sampling Study = 1852 x 0.445 = 824.14 Hrs.

= 49448.4 Min.

Average Cataloging Time per Monograph
= 49448.4/2166 = 22.31 Min.

REASONS FOR THE DIFFERENCE BETWEEN THE TWO STUDIES OF THE AVERAGE TIME REQUIRED TO CATALOG A MONOGRAPH IN THE SOCIAL SCIENCES SECTION

In the Summer when the time and cost study was conducted, the Social Sciences Section of the Cataloging Department had four experienced employees and the cataloging operation was very smooth. During the period of the work sampling study two changes took place in the section which significantly altered its performance. Two new, inexperienced L.C. Catalogers replaced the two experienced L.C. Catalogers. ILR monographs, which require alterations in the cataloging procedures of CUL, were newly introduced into the Social Sciences Section.

The two new L.C. Catalogers who were hired on August 19 and August 29, were in a period of intensive training for the month of September during which they required planning of their daily work,detailed instruction, and review of all work that they performed. This absorbed muc of the time of the supervisor of the section and of the two experienced L.C. Catalogers who left on September 9 and September 27.

Following the period of intensive training an L.C. Cataloger is spot-checked for six months to a year to determine problems that he or she might be having. This continued spot-checking and continued instruction and counseling placed a substantial drain on the supervisor's time.

Introduction of the ILR monographs presented further obstacles to the smooth operation of the Social Sciences Section. Initially the ILR Shelf List was incomplete and the CUL Series Authority File was not updated to reflect all of the ILR differences. Some other complications were:

1) Call Numbers.

Some class numbers used by ILR are not consistent with CUL practice. Many times the Cutter Number does not conform to CUL practice. These inconsistencies between ILR call numbers and the standard form for CUL call numbers complicate the work process. If the problem has not been recognized before, it has to be referred to the supervisor, and a procedure has to be developed to handle it. Simple procedures might involve erasing the call number on a book's slip and changing it to the ILR form. More complex procedures might involve making changes in the Shelf List, the Dictionary catalog, and the ILR catalog.

2) Subject Headings.

To accomodate ILR the non-LC subject heading (Labor Unions) is used instead of (Trade-Unions). When using a record already in the OCLC system, Trade-Unions must be changed to Labor Unions before cards are produced. When inputting a record into the OCLC system, the record must first be input with Trade-Unions to conform to OCLC standards, and then it must be called up to have Trade-Unions changed

to Labor Unions before CUL can order cards.

3) Series Entries.

In some instances ILR treated a series differently than CUL. This has to be noted and in certain cases an extra card for ILR must be ordered.

4) Extra cards.

ILR requires one extra card for each book published during the last two years.

5) Oversize books.

ILR does not use a + sign on oversize books as most other CUL libraries do. This has to be remembered for each ILR book in hand.

6) Older Editions.

Cataloging of older editions must be changed to match what is being done with the new ones.

7) OCLC Operations.

OCLC catalog profile for ILR was not programmed in the beginning so the Social Sciences Section had to manually order three sets of cards for each title.

All of the above combined to slow the normal pace of work and to alter its course. As the new L.C. Catalogers gain experience, as the whole of the Social Sciences Section adapts to the introduction of the ILR material,

and as further standardization is achieved, it is believed that the average time for cataloging an ILR monograph will be reduced.

APPENDIX V.

DISCUSSION OF THE CONFIDENCE INTERVALS FOR THE MEAN PROCESS TIME

As mentioned in Appendix II, during the Time Study, the output of the Original and L.C. Catalogers of the Social Sciences Section of the Catalog Department was studied. The time required to perform the 'Desk Work' and the 'Terminal Work' was noted by the catalogers for each monograph. In case a monograph needed Original Cataloging, the time required for 'Proofreading' was also found.

I wrote a PL/C program to compute the mean process time, the standard deviation, sample variance and intervals for 90, 95 and 99% confidence levels for each type of Cataloging and for each step involved.

The intervals for the Mean Process Cost for each step at 90, 95 and 99% confidence levels, is computed by simply multiplying the limits of the process time intervals by the average wage of the employees doing that job.

The Program listing and its results for each type of Cataloging are given on the following pages.

Table X shows the results of the time and cost intervals for the various confidence levels. The last column in the table shows that in 90% of the cases the cost of L.C. Cataloging will not vary more than 3.3 cents, the cost of Original Cataloging will not vary more than 17.89 cents and

the cost of Cataloging a Member Copy will not vary more than 25 cents per monograph from their respective Mean Process Costs given in Table VI or obtained in the results of the PL/C programs.

I have also written a PL/C program to determine the Sample Sizes of monographs to give the Mean Process Time within the intervals of ± 0.5, ± 1.0, ± 1.5, ± 2.0, ± 3.0, ± 5.0 or ± 7.5 for 90, 95 and 99% confidence levels, for each step involved in the Cataloging Process of a book. Based upon the observed values of variance during the Time Study the program listing and the results in the form of Table is also presented at the end.

PL/C LISTING AND OUTPUT TO DETERMINE CONFIDENCE INTERVALS

```
*PL/C IOS*OWAIS BATUNUS*
*OPTIONS IN EFFECT*      PAGE=0010,TIME=(000,003),ERRORS=(020,020),SORMGIN=(002,072,001),LINECNT=060,BOUNDARY,
*OPTIONS IN EFFECT*      FLAG,NOXREF,NOATR,NOLIST,NOEF,SOURCE,DUMP,NODUMPARPAT,NOM91,NOCOMMENTS,CHECK

     /*****************************************************/                PL/C-IT.5000  07/18/74 15:29 PAGE   1

  STMT LEVEL NEST BLOCK      SOURCE STATEMENT                                                    ID FIELD

                             /*****************************************************/
                             /*                THIS  IS  A  PL/C  PROGRAM WRITTEN  TO       */
                             /* COMPUTE THE MEAN, VARIANCE AND THE CONFIDENCE LEVEL FOR THE */
                             /* PROCESSING TIME FOR THE BOOKS IN OLIN LIBRARY. IT CAN ALSO  */
                             /* BE USED TO CALCULATE THE COST OF PERFORMING A CERTAIN TASK  */
                             /* IF THE WAGE OF THE WORKER   DOING THAT JOB IS KNOWN.        */
                             /*  IN THE FOLLOWING PROGRAM THE FIRST DATA MUST SHOW THE      */
                             /* NUMBER OF DIFFERENT BATCHES USEDIN THIS RUN. FOR EACH       */
                             /* BATCH  SAMPLE SIZE MUST BE SHOWN ON THE FIRST CARD THEN ON  */
                             /* ANOTHER WRITE THE TITLE OF THAT BATCH, THEN THE WAGE OF     */
                             /* THE WORKER DOING THAT JOB. THE PROCESS TIME MUST THEN       */
                             /* FOLLOW SEPARATED BY A BLANK OR A COMMA OR EACH ON ONE CARD. */
                             /*  IN THIS PROGRAMSAMPLE SIZE SHOULD BE 10,16,25,40,56,60 OR  */
                             /* MORE THAN 60. FOR OTHER SAMPLE SIZES SLIGHT MODIFICATION IS */
                             /* NECESSARY.                                  OWAIS BATUNUS   */
                             /*****************************************************/

   1                         COMPUTE: PROCEDURE OPTIONS(MAIN);
   2     1         1           DCL (L90,U90,T90,L95,U95,T95,L99,U99,T99) FLOAT DECIMAL;
   3     1         1           DCL (L1,L2,L3,V90,V95,V99) FLOAT DECIMAL;
   4     1         1           DCL (M,SMM,S,K,Q,V) FLOAT DECIMAL;
   5     1         1           DCL (I,N,Z) FIXED DECIMAL;
   6     1         1           DCL (WAGE, COST) FLOAT DECIMAL;
   7     1         1           DCL TITL CHAR(80) VAR;

                                   /* L90, L95, L99 AND U90, U95, U99 ARE THE LOWER AND UPPER */
                                   /* LIMITS FOR THE RESPECTIVE CONFIDENCE  INTERVALS, T90,   */
                                   /* T95, T99 ARE THE  100(1-B/2) PERCENTILE OF THE  T-DIST. */
                                   /* V90, V95, V99 ARE USED TO FIND PERCENT VARIATION.       */
                                   /* K IS SUM OF THE PROCESSING TIMES, M IS THE MEAN PROC.   */
                                   /* TIME, SMM IS THE SUM OF THE SQUARES OF THE DIFFERENCE   */
                                   /* PROCESSING TIMES AND THEIR MEAN.  S IS THE DEVIANCE.    */
                                   /* V  THE SAMPLE VARIANCE. L1, L2, L3 AND Q ARE USED TO    */
                                   /* CALCULATE THE LOWER AND THE UPPER BOUNDS. T & N ARE     */
                                   /* INTEGERS, N BEING THE SAMPLE SIZE.                      */

   8     1         1           GET LIST(Z);

   9     1         1           DO J = 1 TO Z;
  10     1    1    1            GET LIST (N);
  11     1    1    1            GET LIST(TITL); GET LIST(WAGE);
                                   /* READ DATA, FIND MEAN, STANDARD DEVIANCE AND  VARIANCE   */
  13     1    1    1           PERFORM; BEGIN; DCL A(N) FLOAT DEC;
  15     2    1    2                    K = 0;
  16     2    1    2                    DO I = 1 TO N BY 1; GET LIST(A(I)); K = K + A(I); END;
  20     2    1    2                    M = K/N;
  21     2    1    2                    SMM = 0;
  22     2    1    2                    DO I = 1 TO N; SMM = SMM + (M-A(I))**2; END;
  25     2    1    2                    V = SMM/(N-1); S = SQRT(V);

  27     2    1    2                        END PERFORM;

  28     1    1    1            COST = (M*WAGE)/60;
  29     1    1    1           IF N = 10 THEN DO; T90 = 1.833; T95 = 2.262; T99 = 3.25; END;
  34     1    1    1           IF N = 16 THEN DO; T90 = 1.740; T95 = 2.110; T99 = 2.898;END;
  41     1    1    1           IF N = 25 THEN DO; T90 = 1.711; T95 = 2.064; T99 = 2.797; END;
  47     1    1    1           IF N = 40 THEN DO; T90 = 1.684; T95 = 2.021; T99 = 2.704;END;
  53     1    1    1           IF N = 56 THEN DO; T90 = 1.672; T95 = 2.002; T99 = 2.393; END;
  59     1    1    1           IF N = 60 THEN DO; T90 = 1.671; T95 = 2.000; T99 = 2.660; END;
  65     1    1    1           IF ((N>60)&(N<=120)) THEN DO;
  67     1    2    1               T90 = 1.671 -((  0.013/60 ) * ( N - 60 ));
  68     1    2    1               T95 = 2.000 -((  .0003S * ( N - 60 ));
  69     1    2    1               T99 = 2.660 - (( 0.043/60) * (N - 60)); END;
  71     1    1    1           IF N > 120 THEN DO; T90 = 1.645; T95 = 1.960; T99 = 2.576; END;
  77     1    1    1           Q = S/( SQRT(N));
  78     1    1    1           L1 = T90*Q;  L2 = T95*Q;  L3 = T99*Q;
  81     1    1    1           L90 = M - L1; L95 = M - L2; L99 = M- L3;
  84     1    1    1           U90 = M + L1;  U95 = M + L2;  U99 = M + L3;
  87     1    1    1           V90 = 100 * L1/M; V95 = 100 * L2/M; V99 = 100 * L3/M;
  90     1    1    1            PUT SKIP(5) LIST(TITL);
  91     1    1    1            PUT SKIP LIST('-------------------------------');
  92     1    1    1            PUT SKIP(3) EDIT('MEAN PROCESS TIME=',M)(A,F(7,2));
  93     1    1    1           PUT SKIP LIST('------------------------');
  94     1    1    1           PUT SKIP(3) EDIT('STANDARD DEVIANCE=',S)(A,F(7,2));
  95     1    1    1           PUT SKIP LIST('------------------------');
  96     1    1    1           PUT SKIP(3) EDIT('SAMPLE   VARIANCE=',V)(A,F(7,2));
  97     1    1    1           PUT SKIP LIST('------------------------');

  98     1    1    1           PUT SKIP(3) LIST(' 90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS');
  99     1    1    1           PUT SKIP LIST(' ------------------------------------------');
 100     1    1    1           PUT SKIP EDIT(' TIME IS   (',L90,',',U90,')  VARIES +-',V90,'%')
                                  (A,F(6,2),A,F(7,2),A,F(4,1),A);
 101     1    1    1           PUT SKIP LIST(' ------------------------------------------');
 102     1    1    1           PUT SKIP(3) LIST(' 95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS');
 103     1    1    1           PUT SKIP LIST(' ------------------------------------------');
 104     1    1    1           PUT SKIP EDIT(' TIME IS   (',L95,',',U95,')  VARIES +-',V95,'%')
                                  (A,F(6,2),A,F(7,2),A,F(4,1),A);
 105     1    1    1           PUT SKIP LIST(' ------------------------------------------');
 106     1    1    1           PUT SKIP(3) LIST(' 99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS');
 107     1    1    1           PUT SKIP LIST(' ------------------------------------------');
 108     1    1    1           PUT SKIP EDIT(' TIME IS   (',L99,',',U99,')  VARIES +-',V99,'%')
                                  (A,F(6,2),A,F(7,2),A,F(4,1),A);
 109     1    1    1           PUT SKIP LIST(' ------------------------------------------');

 110     1    1    1            PUT SKIP(3) EDIT('LABOR COST OF PROCESSING ONE BOOK=  $',COST)
                                   (A,F(7,4));
 111     1    1    1            PUT SKIP LIST('------------------------------------------');

 112     1    1    1            END;

 113     1         1           END COMPUTE;
```

L.C. CATALOGING DESK WORK

MEAN PROCESS TIME= 9.66

STANDARD DEVIANCE= 5.37

SAMPLE VARIANCE= 28.89

90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (9.14, 10.19) VARIES +- 5.3%

95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (9.04, 10.29) VARIES +- 6.3%

99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (8.85, 10.47) VARIES +- 8.4%

LABOR COST OF PROCESSING ONE BOOK= $ 0.5499

L.C. CATALOGING OCLC TERMINAL

MEAN PROCESS TIME= 3.83

STANDARD DEVIANCE= 1.72

SAMPLE VARIANCE= 2.94

90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (3.66, 4.00) VARIES +- 4.3%

95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (3.63, 4.03) VARIES +- 5.1%

99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (3.57, 4.09) VARIES +- 6.8%

LABOR COST OF PROCESSING ONE BOOK= $ 0.2183

L.C. CATALOGING TOTAL TIME

MEAN PROCESS TIME= 13.50

STANDARD DEVIANCE= 6.01

SAMPLE VARIANCE= 36.12

90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (12.92, 14.08) VARIES +- 4.2%

95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (12.81, 14.19) VARIES +- 5.1%

99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (12.59, 14.41) VARIES +- 6.7%

LABOR COST OF PROCESSING ONE BOOK= $ 0.7684

NEW SAMPLE ORIGINAL #FMBFR COPY DESK WORK

MEAN PROCESS TIME= 14.15

STANDARD DEVIANCE= 9.94

SAMPLE VARIANCE= 98.95

90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (12.57, 16.94) VARIES +-14.7%

95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (12.14, 17.17) VARIES +-17.7%

99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (11.63, 17.68) VARIES +-21.1%

LABOR COST OF PROCESSING ONE BOOK= $ 1.3393

NEW SAMPLE ORIGINAL #FMBFR COPY TERMINAL WORK

MEAN PROCESS TIME= 6.18

STANDARD DEVIANCE= 3.42

SAMPLE VARIANCE= 11.70

90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (5.42, 6.93) VARIES +-12.1%

95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (5.28, 7.08) VARIES +-14.5%

99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (5.10, 7.25) VARIES +-17.3%

LABOR COST OF PROCESSING ONE BOOK= $ 0.5609

NEW SAMPLE ORIGINAL MEMBER COPY TOTAL TIME

MEAN PROCESS TIME= 20.93

STANDARD DEVIANCE= 12.54

SAMPLE VARIANCE= 157.40

90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (18.18, 23.69) VARIES +-13.1%

95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (17.64, 24.23) VARIES +-15.7%

99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS TIME IS (16.99, 24.88) VARIES +-18.8%

LABOR COST OF PROCESSING ONE BOOK= $ 1.9008

ORIGINAL CATALOGING DEEP COPY

MEAN PROCESS TIME= 26.24

STANDARD DEVIANCE= 10.71

SAMPLE VARIANCE= 114.80

90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
TIME IS (24.26, 28.25) VARIES +- 7.6%

95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
TIME IS (23.87, 28.65) VARIES +- 9.0%

99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
TIME IS (23.04, 29.43) VARIES +-12.0%

LABOR COST OF PROCESSING ONE BOOK= $ 2.3833

ORIGINAL CATALOGING INPUT

MEAN PROCESS TIME= 6.05

STANDARD DEVIANCE= 2.40

SAMPLE VARIANCE= 5.74

90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
TIME IS (5.60, 6.49) VARIES +- 7.3%

95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
TIME IS (5.51, 6.58) VARIES +- 8.8%

99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
TIME IS (5.33, 6.74) VARIES +-11.7%

LABOR COST OF PROCESSING ONE BOOK= $ 0.5490

ORIGINAL CATALOGING PROOF READING

MEAN PROCESS TIME= 3.05

STANDARD DEVIANCE= 1.21

SAMPLE VARIANCE= 1.46

90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
TIME IS (2.82, 3.27) VARIES +- 7.3%

95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
TIME IS (2.78, 3.31) VARIES +- 8.8%

99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
TIME IS (2.69, 3.40) VARIES +-11.7%

LABOR COST OF PROCESSING ONE BOOK= $ 0.2767

```
 ORIGINAL CATALOGING TOTAL TIME
 ------------------------------

MEAN PROCESS TIME=  39.3*
 -------------------------

STANDARD DEVIATION=  11.37
 -------------------------

SAMPLE   VARIANCE= 129.36
 -------------------------

 90% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
 --------------------------------------------
 TIME IS   ( 33.23,  37.46)  VARIES +- 5.9%
 --------------------------------------------

 95% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
 --------------------------------------------
 TIME IS   ( 32.81,  37.88)  VARIES +- 7.1%
 --------------------------------------------

 99% CONFIDENCE INTERVAL FOR THE MEAN PROCESS
 --------------------------------------------
 TIME IS   ( 31.98,  38.71)  VARIES +- 9.5%
 --------------------------------------------

LABOR COST OF PROCESSING ONE BOOK=  $ 3.2080
 -------------------------------------------


IN STMT  113  PROGRAM RETURNS FROM MAIN PROCEDURE


ALL ACTIVE BLOCKS AND SCALAR AUTOMATIC VARIABLES
 BLOCK #     1 (MAIN PROCEDURE)

J=       5              TTTL=' ORIGINAL CATALOGING TOTAL TIME'      COST= 3.20801E+00    WAGE= 5.44500E+00
/=       4              N=      80              I=      81          V= 1.29369E+02       Q= 1.27166E+00
K= 2.42800E+03          R= 1.13740E+01          SMM= 1.02201E+04    M= 3.53500E+01       V99= 9.51736E+00
V95= 7.17094E+00        V90= 5.99557E+00        L3= 3.36438E+00     L2= 2.53492E+00      L1= 2.11943E+00
T99= 2.64566E+00        U99= 3.87147E+01        L99= 3.19856E+01    T95= 1.99340E+00     U95= 3.78849E+01
L95= 3.28150E+01        T90= 1.66666E+00        U90= 3.74694E+01    L90= 3.32305E+01

LABEL/ENTRY STMT COUNT  LABEL/ENTRY STMT COUNT
COMPUTE     0001 00001  PERFORM     0013 00004

 CORE USAGE(BYTES): SYMBOL TABLE 5298. OBJECT CODE 4464. STATIC AND EXTERNAL STORAGE 0000. AUTOMATIC STORAGE 1480. UNUSED
     38942.

COMPILE TIME   0.45 SECONDS.
```

TABLE X. CONFIDENCE INTERVALS FOR PROCESS TIMES AND COSTS

1. L.C. CATALOGING

CONFIDENCE LEVEL	LOWER AND UPPER LIMITS PROCESS TIME (min.)	WAGE $/HR.	PROCESS TIME x WAGE/60	LOWER AND UPPER LIMITS PROCESS COST ($)	($)
90%	12.92	3.415	12.92 x 3.415/60	$ 0.7353	± 0.0330
	14.08	3.415	14.08 x 3.415/60	$ 0.8013	
95%	12.81	3.415	12.81 x 3.415/60	$ 0.7291	± 0.0392
	14.19	3.415	14.19 x 3.415/60	$ 0.8076	
99%	12.59	3.415	12.59 x 3.415/60	$ 0.7165	± 0.0515
	14.40	3.415	14.40 x 3.415/60	$ 0.8196	

2. ORIGINAL CATALOGING

CONFIDENCE LEVEL	LOWER AND UPPER LIMITS PROCESS TIME (min.)	WAGE $/HR.	PROCESS TIME x WAGE/60	LOWER AND UPPER LIMITS PROCESS COST ($)	($)
90%	33.23	5.07615	33.23 x 5.07615/60	$ 2.8113	± 0.1789
	37.46	5.07615	37.46 x 5.07615/60	$ 3.1691	
95%	32.81	5.07615	32.81 x 5.07615/60	$ 2.7757	± 0.2145
	37.88	5.07615	37.88 x 5.07615/60	$ 3.2047	
99%	31.98	5.07615	31.98 x 5.07615/60	$ 2.7055	± 0.2847
	38.71	5.07615	38.71 x 5.07615/60	$ 3.3749	

3. MEMBER COPY CATALOGING

CONFIDENCE LEVEL	LOWER AND UPPER LIMITS PROCESS TIME (min.)	WAGE $/HR.	PROCESS TIME x WAGE/60	LOWER AND UPPER LIMITS PROCESS COST ($)	($)
90%	18.18	5.445	18.18 x 5.445/60	$ 1.6498	± 0.2500
	23.69	5.445	23.69 x 5.445/60	$ 2.1498	
95%	17.64	5.445	17.64 x 5.445/60	$ 1.6008	± 0.2990
	24.23	5.445	24.23 x 5.445/60	$ 2.1988	
99%	16.99	5.445	16.99 x 5.445/60	$ 1.5418	± 0.3580
	24.88	5.445	24.88 x 5.445/60	$ 2.2578	

LISTING AND OUTPUT FOR SAMPLE SIZES DETERMINATION FOR VARIOUS CONFIDENCE LEVELS AND INTERVALS

```
*PL/C ID='CHRIS RAYUNUS'

*OPTIONS IN EFFECT*      PAGES=010,TIME=(000,003),ERRORS=(020,020),SORTGIN=(002,072,001),LINECNT=060,BOUNDARY,
*OPTIONS IN EFFECT*      FLAG,NOXREF,NOATR,POLIST,NOEF,SOURCE,DUMP,NOOUTARRAY,NOM91,NOCOMMENTS,CHECK

      /*************************************************************/          PL/C-IT,5000  07/18/74 14:36 PAGE   1

   STMT LEVEL NEST BLOCK      SOURCE STATEMENT                                        ID FIELD

                              /*****************************************************************/
                              /*  PL/C PROGRAM TO COMPUTE THE SAMPLE SIZE OF MONOGRAPHS IN     */
                              /* LIBRARY REQUIRED TO GIVE  CONFIDENCE LEVELS OF 90, 95 AND     */
                              /* 99% FOR DIFFERENT INTERVALS OF PROCESSING TIMES, RAYUNUS.     */
                              /*****************************************************************/
     1                        BARR: PROCEDURE OPTIONS(MAIN);
     2     1         1          DCL (CL(3), SIGMA(10), D(7)) FLOAT DECIMAL;
     3     1         1          DCL (I,J,K,L,N) FIXED DECIMAL;
     4     1         1            GET LIST(CL, SIGMA, D);
     5     1         1            PUT SKIP(4) LIST('  THE VALUE OF SIGMA USED FOR THE FOLLOWING');
     6     1         1               PUT SKIP LIST('  ---------------------------------------');
     7     1         1               PUT SKIP LIST('       TABLE IS:');
     8     1         1               PUT SKIP LIST('       ----------');
     9     1         1               PUT SKIP LIST(' 1.  FOR L.C. CATALOGING');
    10     1         1               PUT SKIP LIST(' ------------------------');
    11     1         1            PUT SKIP(2) EDIT('          DESK WORK =   ',SIGMA(1))(A,F(5,1));
    12     1         1               PUT SKIP EDIT('          TERMINAL  =   ',SIGMA(2))(A,F(5,1));
    13     1         1               PUT SKIP EDIT('          TOTAL TM, =   ',SIGMA(3))(A,F(5,1));
    14     1         1            PUT SKIP(2) LIST(' 2.  FOR MEMBER COPY ORIGINAL');
    15     1         1            PUT SKIP    LIST(' ----------------------------');
    16     1         1            PUT SKIP(2) EDIT('          DESK WORK =  ', SIGMA(4))(A,F(5,1));
    17     1         1            PUT SKIP    EDIT('          TERMINAL  =  ', SIGMA(5))(A,F(5,1));
    18     1         1            PUT SKIP    EDIT('          TOTAL TM, =  ', SIGMA(6))(A,F(5,1));
    19     1         1            PUT SKIP(2) LIST(' 3.  FOR ORIGINAL CATALOGING');
    20     1         1            PUT SKIP    LIST(' ---------------------------');
    21     1         1            PUT SKIP(2) EDIT('          DESK WORK =  ', SIGMA(7))(A,F(5,1));
    22     1         1            PUT SKIP    EDIT('          INPUT     =  ', SIGMA(8))(A,F(5,1));
    23     1         1            PUT SKIP    EDIT('          PROOFRD,  =  ', SIGMA(9))(A,F(5,1));
    24     1         1            PUT SKIP    EDIT('          TOTAL TM, =  ', SIGMA(10))(A,F(5,1));
    25     1         1          PUT SKIP(5);
    26     1         1                DO L = 1 TO 113;
    27     1    1    1               PUT EDIT('-')(A);  END;
    29     1         1               PUT EDIT('!')(A);
    30     1         1          PUT SKIP(1);
    31     1         1          PUT EDIT('!  CONFD.   ! CONFD.!      L.C. CATALOGING       !',
                                '    MEMBER COPY ORIGINAL   !',
                                '     ORIGINAL CATALOGING          !') (A,A,A);
    32     1         1          PUT SKIP(1);
    33     1         1                DO L = 1 TO 113;
    34     1    1    1               PUT EDIT('-')(A);  END;
    36     1         1               PUT EDIT('!')(A);
    37     1         1          PUT SKIP(1);
    38     1         1          PUT EDIT('  INTERVAL ! INTVL.!     DESK    TERM    TOTAL  !',
                                '    DESK    TERM    TOTAL  !',
                                '    DESK    INPUT  PROOFRD, TOTAL  !')(A,A,A);
    39     1         1             DO I = 1 TO 8;
    40     1    1    1               IF I = 1 THEN PUT SKIP(1);
    42     1    1    1                         ELSE PUT SKIP(2);
    43     1    1    1               DO L = 1 TO 113;
    44     1    2    1                 PUT EDIT('-')(A);
    45     1    2    1                    END;
    46     1    1    1                 PUT EDIT('!')(A);
    47     1    1    1                 IF I = 8 THEN GOTO BYPASS;
    49     1    1    1               DO J = 1 TO 3;
    50     1    2    1                 DO K = 1 TO 10;
    51     1    3    1                 N = (CL(J)*SIGMA(K)/D(I))**2;
    52     1    3    1                 IF K = 1 THEN DO ;
    54     1    4    1                    PUT SKIP(2);
    55     1    4    1                 IF J = 1 THEN PUT LIST('!          !  90%  !');
    57     1    4    1                 IF J = 2 THEN PUT EDIT('!   +-',D(I),'  !  95%  ! ')
                                        (A,F(4,2),A);
    59     1    4    1                 IF J = 3 THEN PUT LIST('!          !  99%  !'); END;
    62     1    3    1                 PUT EDIT(N)(F(8));
    63     1    3    1                 IF ((K=3)|(K=6)|(K=10)) THEN PUT EDIT('   !')(A);
    65     1    3    1                 END;
    66     1    2    1               END;
    67     1    1    1             BYPASS: END;
    68     1         1           END BARR;
```

THE VALUE OF SIGMA USED FOR THE FOLLOWING

TABLE IS:

1. FOR L.C. CATALOGING

DESK WORK = *.3
TERMINAL = 1.7
TOTAL TM. = 6.0

2. FOR MEMBER COPY ORIGINAL

DESK WORK = 9.3
TERMINAL = 8.5
TOTAL TM. = 11.0

3. FOR ORIGINAL CATALOGING

DESK WORK = 10.7
INPUT = 2.4
PROOFRD. = 1.2
TOTAL TM. = 11.2

CONFD. INTERVAL	CONFD. INTVL.	L.C. CATALOGING DESK	L.C. CATALOGING TERM	L.C. CATALOGING TOTAL	MEMBER COPY ORIGINAL DESK	MEMBER COPY ORIGINAL TERM	MEMBER COPY ORIGINAL TOTAL	ORIGINAL CATALOGING DESK	ORIGINAL CATALOGING INPUT	ORIGINAL CATALOGING PROOFRD.	ORIGINAL CATALOGING TOTAL
	90%	312	32	389	942	120	1312	1241	62	15	1367
+-0.50	95%	443	45	553	1337	171	1862	1762	88	22	1941
	99%	764	79	954	2308	295	3215	3042	152	38	3350
	90%	78	8	97	235	30	326	310	15	3	341
+-1.00	95%	110	11	138	334	42	465	440	22	5	485
	99%	191	19	238	577	73	803	760	38	9	837
	90%	34	3	43	104	13	145	137	6	1	151
+-1.50	95%	49	5	61	148	19	206	195	9	2	215
	99%	84	8	106	256	32	357	338	16	4	372
	90%	19	2	24	58	7	82	77	3	0	80
+-2.00	95%	27	2	34	83	10	116	110	5	1	121
	99%	47	4	59	144	18	200	190	9	2	209
	90%	6	0	10	26	3	36	34	1	0	37
+-3.00	95%	12	1	15	37	4	51	48	2	0	53
	99%	21	2	26	64	8	89	84	4	1	93
	90%	3	0	3	9	1	13	12	0	0	13
+-5.00	95%	4	0	5	13	1	18	17	0	0	19
	99%	7	0	9	23	2	32	30	1	0	33
	90%	1	0	1	4	0	5	5	0	0	6
+-7.50	95%	1	0	2	5	0	8	7	0	0	8
	99%	3	0	4	10	1	14	13	0	0	14

APPENDIX VI.

COMPARISON OF THE TERMINAL USAGE RATES WITH THE ESTIMATES FOR SOME OTHER OCLC LIBRARIES[1]

	Present Study	Estimate Based on Shrut and Koehler Study
Input	6.05 Min.	6.0 Min.
Searching	0.8 Min	2.0 Min.
Cataloging[2] (OCLC Terminal)		
L.C. Cataloging = 3.83 Member Copy = 6.18 Average based upon 291 for L.C. and 18 for Member Copy (from Time Study) Sample	= 3.96 Min.	4.0 Min.
Proofreading	= 3.05 Min.	3.0 Min.

1 Koehler, D., Shrut, B., Evaluation of a Computer-Based Cataloging Support System for use by the Cornell University Libraries, May 1973, Ithaca, N.Y.

2 A study of OCLC utilization in 36 Ohio academic libraries showed that an average of 14 books could be cataloged on the terminal per hour, when using records already in the system. This gives an average cataloging time of about 4.3 minutes per title on the terminal.
(Ref: OCLC Newsletter No. 75, 18 Nov., 1974)

APPENDIX VII.

COMPARISON OF WORKLOAD ON THE EMPLOYEES DURING DECEMBER 1972 TO NOVEMBER 1973 and DECEMBER 1973 TO NOVEMBER 1974

During December 1972 to November 1973:

Total number of titles cataloged = 82745

Average number of catalogers = 43

Average number of titles cataloged per cataloger = 82745/43 = 1924

Average time for cataloging a title = 2028 x 0.547 x 60/1924 = 34.59 min.

Similary, during December 1973 to November 1974:

Total number of titles cataloged = 79867

Average number of catalogers = 43

Average number of titles cataloged per cataloger = 1857

Average time for cataloging a title = 2028 x 0.547 x 60/1857 = 35.84 min.

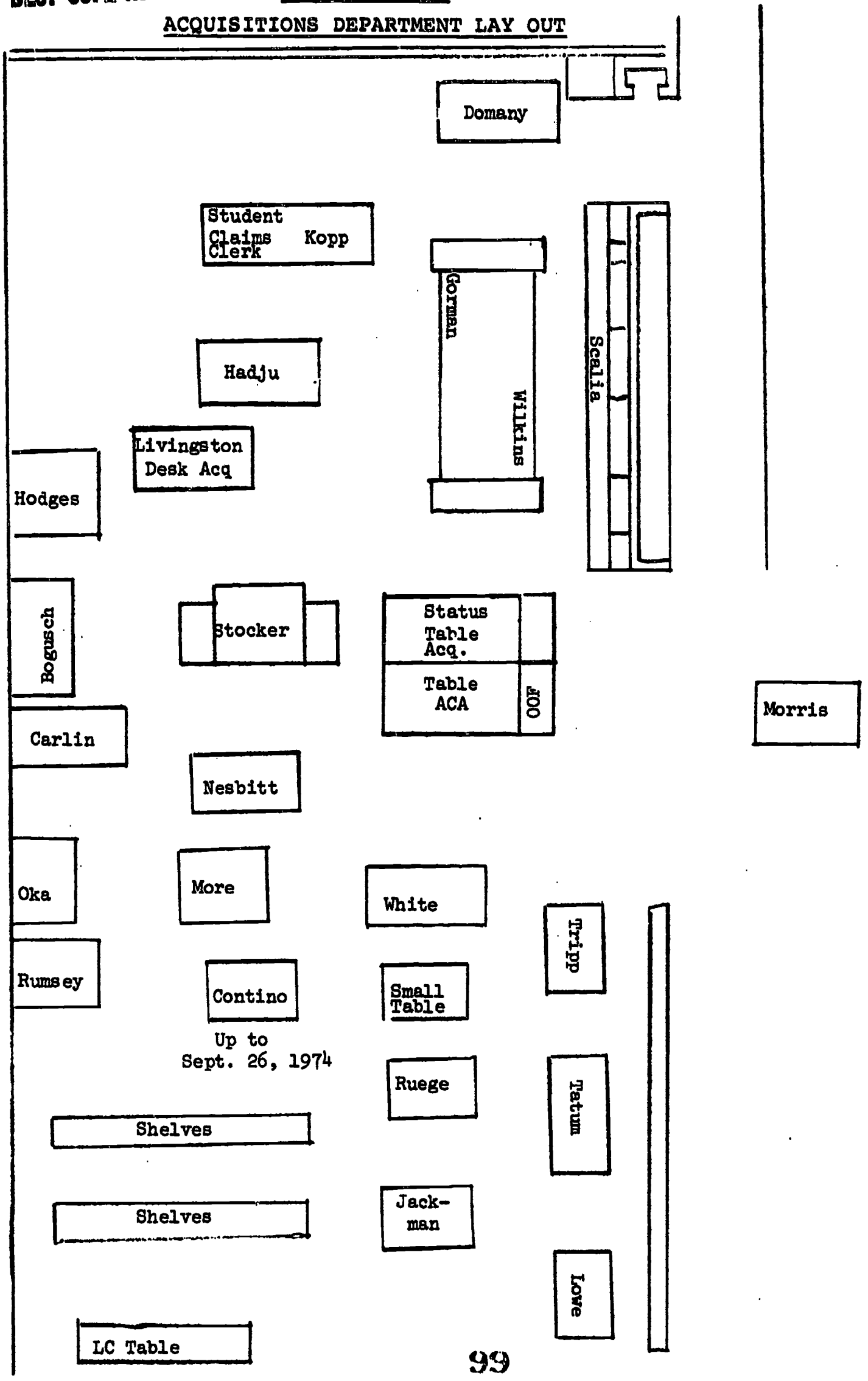
Increment in the average process time to catalog a title = 35.84 - 34.59 = 1.25 min.

This increment in the time of cataloging is mainly due

to the fact that fewer titles have been cataloged during 1974, whereas the number of catalogers remained the same.

APPENDIX VIII.

ACQUISITIONS DEPARTMENT LAY OUT



CATALOGING DEPARTMENT
LAY OUT

Shelf Lists

Chinese Ni

Chinese Mu

*Soc Sci OCLC-West

Humanities LC Brewer

Chinese Li | Chinese Tu

Chinese | *Hum. OCLC Menke

Soc. Sci. LC Rieger | LC Humanities Gibbard

Humanities Contino | Soc. Sci OCLC Lee

(after Sept. 26,74)

Soc. Sci. LC Ziff | Reclass Danielson

Reclass Bausenbach |

Searcher Huhta | Searcher Barbara

Terminals

Sorting Table

Science LC Sawicki | Science OCLC *Gully

Germanic LC Bogusch | Science OCLC Slon

*RomanceOCLC Niseleo |

Ditmars

Perery

Catalog Dept. Librarian Walker

Catalog Maint. Librarian Kaaret

S.E. Asia Vidmanis | Chinese Searcher

S.E. Asia Lwin | S.E. Asia The

S.E. Asia Oey | S.E. Asia Crawford

S.E. Asia Suprapto | S.E. Asia Suprapto

Cat. Maint. Horton | S. Asia Dave

Romance LC Hickey | Romance Lg. Sercan

Slocum | Music OCLC *Robbins

GermanicOCLC *Anderson | F.Arts OCLC *Sullivan

South Asia Domany | Slavic Rumsey

South Asia *Kayastha | Slavic *Kraft

* Head of Respective Sections

BEST COPY AVAILABLE

BEST COPY AVAILABLE

A SAMPLE OF THE SHEET FOR WORK SAMPLING STUDY

	(PRODUCTIVE)																						(NON-PRODUCTIVE)								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	1	2	3	4	5	6	7	8	
LOCATION →	DESK	CARD CATALOG	SERIES AUTHOR FILE	STATUS LIST TABLE + L.C. TABLES	SHELF LIST	STACKS	BINDING	CARDEX	BUDGET + ACCOUNTING	JACKIE'S DESK	BET. DESK SHELVES	BET. DESK DOWNSTAIRS	KEY PUNCH MACHINE	VERIFIER	Cupboard Shelf	Computer card file	Table L.C. [illegible]					Other Places	Avoidable Delays	Personal	Talking					Others	Remarks
ACTIVITIES →															Storing status list	File the latest and throw the oldest	Sorting Books and slips					Miscellaneous									
NAMES ↓																															
1 MARVIN TATUM																															
2 SUSAN LOWE																															
3 SUSAN JACKMAN																															
4 DEBBIE, TRIPP																															
5 SALLY ROEGE																															
6																															
7																															
8																															
9																															
10 WILMA FISCHER																															
11 MARY WESCHE																															
12 NANCY HELISEVA																															
13 JANET																															
14																															
15																															
16																															
17																															
18																															
19																															

BIBLIOGRAPHY

Barnes, R.M., Work Sampling, W.C. Brown Company, Iowa, 1957.

Business Week, Measuring How Office Workers Work, November 14, 1970.

Ferdinand F. LeimKuhler & Micael D. Cooper, "Cost Accounting for University Libraries". College and Research Libraries, V. 32, 1971.

Gibson, John S., Total Cost of Acquisitions in a Community College, College and Research Libraries, July, 1967.

Grillo, E.V., Beig C.J., Work Measurement in the Office, McGraw Hill Book Company Inc., N.Y., 1959.

Heiland, R.E., Richardson, W.J., Work Sampling, McGraw Hill Book Company, Inc., N.Y., 1957.

Jain, A.K., Sampling and Short Period Usage in Purdue Library, College and Research Libraries, May, 1966.

Lancaster, F. Wilfrid, Systems Design and Analysis for Libraries, Library Trends, University of Illinois, April, 1973.

Morse, Philip M., Probablistic Models for Library Operations, Lecture, Association of Research Libraries, Chicago, Illinois, January 26, 1964.

Pierce, W.O., Work Measurement in Public Libraries, Social Science Research Council, N.Y., 1969.

Schwab, John L., Techniques of Work Measurement.
Day, Donald J., Time Study by Stop Watch, Life Office Management Association, N.Y., 1969.